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ENERGY

A SPECIAL BIBLIOGRAPHY WITH INDEXES

APRIL 1974

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16. Abstract

This literature survey of special energy and energy related documents lists 1708 reports, articles, and other documents introduced into the NASA scientific and technical information system between January 1, 1968, and December 31, 1973. Citations from International Aerospace Abstracts (IAA) and Scientific and Technical Aerospace Reports (STAR) are grouped according to the following subject categories: energy systems; solar energy; primary energy sources; secondary energy sources; energy conversion; energy transport, transmission, and distribution; and energy storage. The index section includes the subject, personal author, corporate source, contract, report, and accession indexes.

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ENERGY

A Special Bibliography
With Indexes

A selection of annotated references to documents that were announced from January 1, 1968 through December 31, 1973 in

- *Scientific and Technical Aerospace Reports (STAR)*
- *International Aerospace Abstracts (IAA).*

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APRIL 1974
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INTRODUCTION

This special literature survey of energy and energy-related documents lists 1708 reports, articles, and other documents that were announced from January 1, 1968 through December 31, 1973 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA)*.

In its subject coverage *Energy* contains references on regional, national, and international energy systems; research and development on fuels and other sources of energy; energy conversion, transport, transmission, distribution, and storage, with special emphasis on use of magnetohydrodynamics, hydrogen, and solar energy. References on remote sensing of energy resources are also included.

The abstracts have been arranged in special subject categories chosen for this publication; the scope of each is described on page viii.

Each entry in the bibliography consists of a bibliographic citation accompanied in most cases by an abstract. The citations, and abstracts when available, are reproduced exactly as they appeared originally in *STAR* or *IAA*, including the original accession numbers from the respective announcement journals. This procedure, which saves time and money, accounts for the variations in type and citation appearances.

Following the abstract sections are six indexes: subject, personal author, corporate source, contract, report, and accession number.

A quarterly continuing bibliography on this subject is planned.

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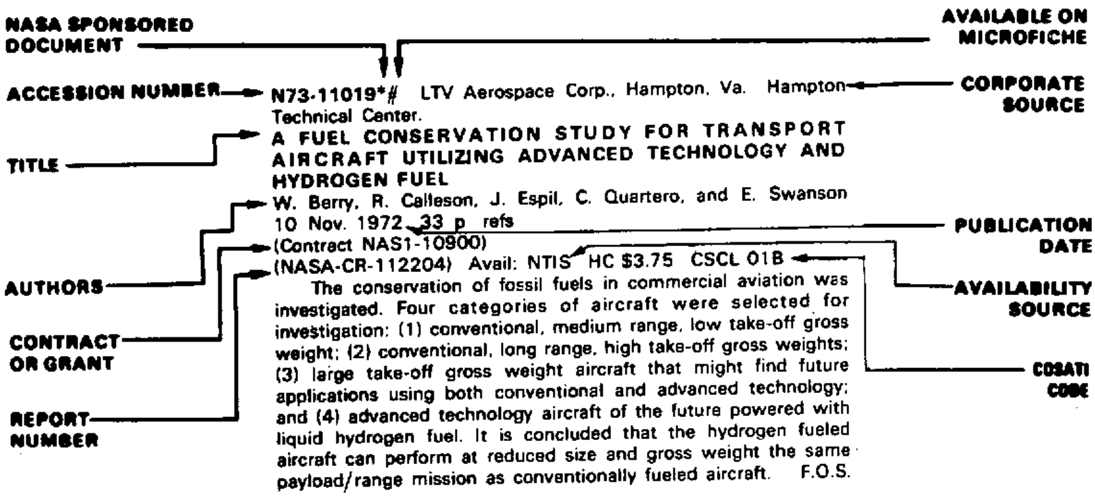

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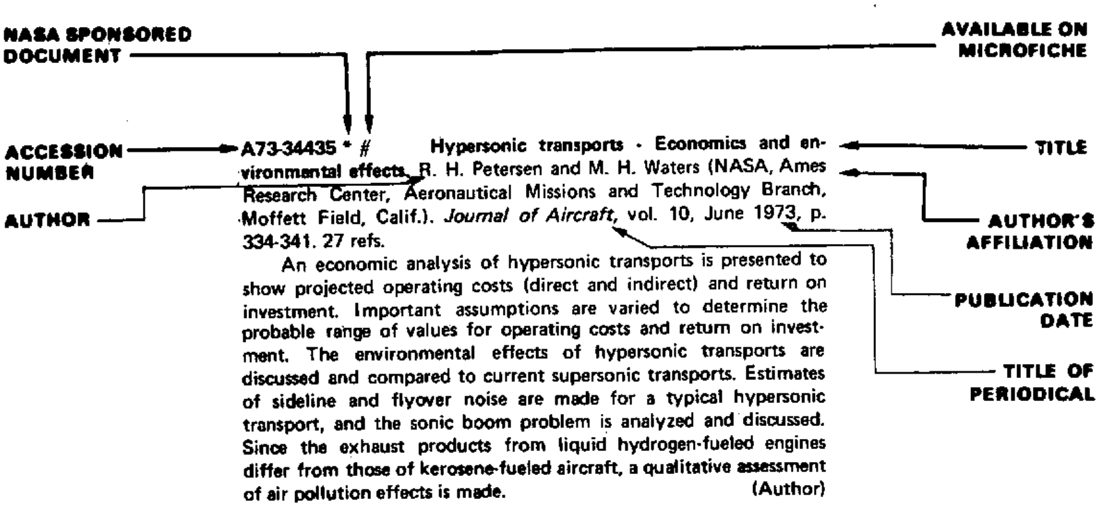

ENERGY

NASA A Special Bibliography

APRIL 1974

01 ENERGY SYSTEMS

Includes energy policies and strategies; regional, national and international energy requirements and legislation; energy conservation options; hydrogen-energy systems; and impact of energy systems on environment.

A68-33457 *

FUTURE COST OF LIQUID HYDROGEN FOR USE AS AN AIRCRAFT FUEL.

Darrell E. Wilcox, Cynthia L. Smith (NASA, Office of Advanced Research and Technology, Mission Analysis Div., Moffett Field, Calif.), Halden C. Totten, and N. C. Hallet (Air Products and Chemicals, Inc., Allentown, Pa.).

IN: AVIATION AND SPACE: PROGRESS AND PROSPECTS; PROCEEDINGS OF THE ANNUAL AVIATION AND SPACE CONFERENCE, BEVERLY HILLS, CALIF., JUNE 16-19, 1968.

New York, American Society of Mechanical Engineers, 1968, p. 471-478. 8 refs.

The cost of LH_2 is a critical factor in the future economic feasibility of hydrogen-fueled aircraft. A study has been made of LH_2 production cost based upon projection of the increased demand associated with hydrogen-fueled aircraft. Production costs were estimated at ten important international locations. Variables investigated were plant capacity, production methods, probable technological advances, and the effects of the geographical location of raw materials and energy sources. The results of the study indicate that the future production cost of LH_2 may range from 8 to 13 cents per pound, depending on the location and quantity required. (Author)

A69-23433

ELECTRICITY FROM MHD: INTERNATIONAL ATOMIC ENERGY AGENCY, SYMPOSIUM ON MAGNETOHYDRODYNAMIC ELECTRICAL POWER GENERATION, WARSAW, POLAND, JULY 24-30, 1968, PROCEEDINGS. VOLUME 1 - CLOSED-CYCLE MHD WITH GASEOUS WORKING FLUIDS (Sections 1-a to 1-g).

Vienna, International Atomic Energy Agency, 1968. 720 p.

In English, French, Russian, and Spanish.

$12.

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ELECTRICAL CONDUCTIVITY AND ENERGY BALANCE IN A NONEQUILIBRIUM PLASMA - NEON-CESIUM, KRYPTON-CESIUM, XENON-CESIUM GAS MIXTURES [ELEKTROPROVODNOST' I BALANS ENERGII V NERAVNOVESNOI PLAZME - SMESI NEON-TSEZII, KRIPTON-TSEZII, KSENON-TSEZII]. Iu. M. Volkov and D. D. Maliuta (Akademiia Nauk SSSR, Moscow, USSR), p. 77-96. 16 refs.

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Vienna, International Atomic Energy Agency, 1968. 793 p. In English, Russian, and French.
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EXPERIMENTAL RESULTS WITH A LIQUID-METAL MHD INDUCTION CONVERTER. M. Ulber and T. Schulz (Allgemeine Elektrizitäts-Gesellschaft, Berlin, West Germany), p. 1979-2004.

FLUID-METAL MHD/STEAM BINARY PLANT ECONOMY FOR CENTRAL STATIONS. L. L. Prem (North American Rockwell Corp., Canoga Park, Calif.), p. 2005-2018.

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INVESTIGATION OF A LIQUID-METAL JET MHD GENERATOR [ISSLEDOVANIE ZHIDKOMETALLICHESKOGO STRUINOGO MGD-GENERATORA]. K. I. Dmitriev, E. A. Zotova, I. A. Ivanov, V. S. Presniakov, and F. R. Ulinich (Akademiia Nauk SSSR, Institut Atomnoi Energii, Moscow, USSR), p. 2035-2046.

EXPERIMENTAL INVESTIGATION OF LIQUID-METAL MHD GENERATORS [EKSPERIMENTAL'NYE ISSLEDOVANIIA ZHIDKOMETALLICHESKIKH MGD-GENERATOROV]. G. A. Baranov, V. F. Vasil'ev, V. A. Glukhikh, V. G. Karasev, I. R. Kirillov, and I. V. Lavrent'ev (Nauchno-Issledovatel'skii Institut Elektrofizicheskoi Apparatury, Leningrad, USSR), p. 2047-2064.

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A69-28021

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Vienna, International Atomic Energy Agency, 1968. 760 p.
In English, French, and Russian.
$12.

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THERMAL RADIATION OF POTASSIUM IN GASES USED IN MAGNETOHYDRODYNAMICS [RAYONNEMENT THERMIQUE DU POTASSIUM DANS LES GAZ UTILISES EN MAGNETOHYDRODYNAMIQUE]. A. Feugier and X. Nguyen Duc (Institut Français du Pétrole, Rueil-Malmaison, Hauts-de-Seine, France), p. 2119-2128. 15 refs.

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EVOLUTION OF THE BOUNDARY LAYER IN THE VICINITY OF THE WALLS OF A MAGNETOAERODYNAMIC GENERATOR [EVOLUTION DE LA COUCHE LIMITE AU VOISINAGE DES PAROIS D'UN GENERATEUR MAGNETOAERODYNAMIQUE]. J. C. Brancher and B. Roy (Compagnie Générale d'Electricité de Paris, Paris, France), p. 2347-2365. 7 refs.

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THE LAMINAR MAGNETOGASDYNAMIC ELECTRODE BOUNDARY LAYER OF A THERMAL NON-EQUILIBRIUM PLASMA. H. A. Claassen (Kernforschungsanlage Jülich GmbH, Jülich, West Germany), p. 2493-2508. 11 refs.

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A69-39477

ELECTRICITY FROM MHD; INTERNATIONAL ATOMIC ENERGY AGENCY, SYMPOSIUM ON MAGNETOHYDRODYNAMIC ELECTRICAL POWER GENERATION, WARSAW, POLAND, JULY 24-30, 1968, PROCEEDINGS. VOLUME 6–INVITED LECTURE, RAPPORTEURS' STATEMENTS AND DISCUSSIONS, ROUND TABLE DISCUSSIONS, INDEXES.
Vienna, International Atomic Energy Agency, 1968. 477 p.
$12.

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SHOCK WAVES. B. Zauderer (General Electric Co., King of

Prussia, Pa.), p. 3573-3589. 12 refs.
MHD LOSSES. H. Weh (Braunschweig, Technische Hochschule, Braunschweig, West Germany), p. 3693-3708. 22 refs.

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A71-12120 Technology assessment. I - **Weighing the benefits and risks of new technologies.** Chauncey Starr (California, University, Los Angeles, Calif.). *Research Management*, vol. 13, Nov. 1970, p. 409-425.

Discussion of an approach to quantitative assessments of social benefits vs social costs of technological developments in use. Specific assessments made or attempted include mining accident rates vs incentive, risk and participation trends for motor vehicles, certified air carriers, and general aviation, electric power generating nuclear plants. Although this study is only exploratory, it does reveal certain interesting points. Public acceptability of risk appears to be crudely proportional to the cube of the benefits (real or imagined). The social acceptance of risk is directly influenced by public awareness of the benefits of an activity, as determined by advertising, usefulness, and the number of people participating. In a sample application of these criteria to atomic power plant safety, it developed that an engineering design objective determined by economic criteria resulted in a design target risk level very much less than the present socially accepted risk for electric power plants. M.V.E.

A71-13026 **Power Sources Symposium, 24th, Atlantic City, N.J., May 19-21, 1970, Proceedings.** Symposium sponsored by the U.S. Army. Red Bank, N.J., PSC Publications Committee, 1970. 228 p. $15.

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Nonlinear vector potential analysis of homopolar inductor alternators. K. F. Schenk, E. A. Erdelyi (Colorado, University, Boulder, Colo.), and R. E. Hopkins (U.S. Army, Mobility Equipment Research and Development Center, Fort Belvoir, Va.), p. 168-171.

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Methanol-oxygen fuel cells. J. E. Wynn (U.S. Army, Electronics Command, Fort Monmouth, N.J.), p. 198-201.

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Optimization of hydrazine-air cells. K. V. Kordesch and M. B. Clark (Union Carbide Corp., Cleveland, Ohio), p. 207-210.

Hydrazine fuel cells. L. C. Hymes, J. E. Ward, and G. L. Reed (Allis-Chalmers, Greendale, Wis.), p. 210-213.

A71-21300 # **Optimization methods for jet-propulsion with respect to exergy.** L. Narjes (Indian Institute of Technology, Madras, India). *Aeronautical Society of India, Journal*, vol. 22, Nov. 1970, p. 209-217. 6 refs.

The paper deals with two optimization procedures by introducing the thermodynamic concepts of exergy and anergy. From purely thermodynamic considerations, the first part of the analysis leads to minimum specific fuel consumption or minimum specific exergy loss which corresponds to maximum thermodynamic efficiency. The second takes into account both capital investment and expenses due to exergy need (or fuel consumption) of the unit. This leads to minimum total cost flux or an economically optimum unit. The optimum conditions are achieved by varying the compressor pressure ratio of the unit in both cases. The results calculated on the basis of adiabatic, incomplete combustion from experimental observations on a furnace burning heavy oil used for steam generation are compared with the results of adiabatic and complete combustion in jet engine combustion chambers. (Author)

A71-22179 * # **Nuclear power for surface effect vehicle and aircraft propulsion.** Frank E. Rom (NASA, Lewis Research Center, Cleveland, Ohio). *American Institute of Aeronautics and Astronautics, Annual Meeting, 7th, Houston, Tex., Oct. 19-22, 1970, Paper 70-1221.* 22 p. 8 refs.

Preliminary results of an economic study that indicates the potential application of nuclear surface effect vehicles and aircraft for carrying transoceanic commerce in the post 1980 time period are presented. A summary of recent encouraging mobile nuclear reactor safety experiments for high speed impacts is also presented. The results of the economic study indicate that there would be a potential need for about 1500 nuclear surface effect vehicles of 10,000 tons gross weight with a speed of 100 knots to handle transoceanic commerce if the shipping cost would be about 1 to 2 cents per ton mile. The study indicates that nuclear powered surface effect vehicles may have the ability to carry cargo at rates less than 2 cents per ton mile. Subsonic nuclear aircraft with a gross weight of 1000 tons may be able to carry cargo at the rate of 4 to 5 cents per ton mile. Very large subsonic nuclear aircraft of the order of 10,000 tons in gross weight may be able to carry cargo at rates less than 2 cents per ton mile. It would take a fleet of 500 such aircraft to handle transoceanic trade that would be economically feasible to carry at 1 to 2 cents per ton mile in 1980. (Author)

A71-27542 **Economics of propulsion systems for air transport. I.** David Huddie. *Esso Air World*, vol. 23, no. 4, 1971, p. 91-96.

Outline of reasons for producing new powerplants and the contributions made by powerplant efficiency and size to aircraft operating economics. The continued growth in aircraft size obliges the engine constructor to develop larger engines. At the same time the need for lower weight and lower fuel consumption to stave off square-cube effects, and social pressures for less nuisance from aircraft (noise and air pollution) demand more advanced designs. Provided that the advance in technology continues to allow this process to occur with each new generation of aircraft there seems to be no reason why transport aircraft should not continue to increase in size since there is no intrinsic natural limit to the size of turbomachinery. F.R.L.

A72-43147 # **The impact of aerospace technology on energy conversion in the 70's.** S. I. Freedman (Pennsylvania, University,

Philadelphia, Pa.). *American Society of Mechanical Engineers, Aerospace Conference, Anaheim, Calif., Sept. 10-13, 1972, Paper 72-Aero-11.* 4 p. Members, $1.00; nonmembers, $3.00.

The author discusses areas in which energy conversion is contributing to the functioning of industrialized society by developing new systems. He describes the relationships between the systems, the various disciplines which form the elements of energy conversion, and several of the aerospace programs which advanced technical capabilities in these areas. (Author)

A72-45216 # **On the economics of space utilization.** G. R. Woodcock (Boeing Co., Aerospace Group, Seattle, Wash.). *International Astronautical Federation, International Astronautical Congress, 23rd, Vienna, Austria, Oct. 8-15, 1972, Paper.* 26 p. 34 refs.

An economical analysis is conducted for assessing potential future developments in space. Particular attention is given to commercial applications. The demand for space-derived services in conventional applications is expected to grow. More and better meteorological satellites will be needed. Equipment is required for the determination of temperature, humidity, and pressure as a function of altitude in connection with endeavors to improve numerical weather prediction capabilities. Aspects of space communications are discussed together with problems of nuclear waste disposal and questions of manufacturing in space. Other application considered are related to space solar power and the extension of human civilization beyond the confines of the earth. G.R.

A73-15741 # **Hydrogen resistojets for primary propulsion of communications satellites.** W. T. Lord, R. C. Parkinson, K. Allen, J. A. Donovan, and P. J. Sherwood (Rocket Propulsion Establishment, Westcott, Bucks., England). In: Electric propulsion and its space applications; Workshop, 2nd, Toulouse, France, June 21-23, 1972, Proceedings. Toulouse, Centre National de la Recherche Scientifique, 1972, p. 381-399. 11 refs.

The first part of the paper describes the RPE 3-kW hydrogen resistojet and gives a summary of its fabrication processes and the test results obtained to date. The performance of this resistojet is designed to be suitable for application in a primary electric propulsion system for geostationary communications satellites. The second part of the paper describes how, by combining hydrogen resistojets with ion motors, it is possible to obtain a mixed-thrustor electric propulsion system which enables a desirable balance to be obtained between payload and transfer time and between power supply and propellant mass. Versatility of performance is accompanied by flexibility of operation, and the introduction of two separate propulsion devices need not necessarily have an adverse effect on reliability. (Author)

A73-17608 * # **Toward a second-generation supersonic transport.** L. K. Loftin, Jr. (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 9th, Washington, D.C., Jan. 8-10, 1973, Paper 73-15.* 11 p. Members, $1.50; nonmembers, $2.00.

A number of promising avenues of research and development are considered in relation to an advanced supersonic transport which has improved range/payload characteristics and lower airport noise and sonic boom than current-generation supersonic transports. The prospects for advanced technology suggest that a high lift-to-drag-ratio configuration incorporating advanced materials and control concepts and utilizing a variable-cycle engine or perhaps an advanced dry turbojet, will yield an advanced supersonic transport which is economically viable and socially acceptable. Hydrogen fuel offers great promise for future supersonic aircraft, however, the formidable problems associated with the use of such fuel probably precludes its use on any near term second-generation supersonic transport. The state of technology in some of the areas discussed is not very far advanced and, consequently, a major effort will be required to bring these technologies to a state of readiness on a timely basis. (Author)

A73-17631 * # **Key technology for airbreathing hypersonic aircraft.** A. L. Nagel and J. V. Becker (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 9th, Washington, D.C., Jan. 8-10, 1973, Paper 73-58.* 12 p. 9 refs. Members, $1.50; nonmembers, $2.00.

This paper reviews recent progress in the key hypersonic technologies, which has been good despite a relatively low priority. Successful hypersonic research engine tests have been made. Active cooling system analyses have shown potential for weight savings, alleviation of structural design problems, and long airframe life. Maturing computerized flow field theories permit optimizing engine-airframe performance. Adequate progress in the future requires an expanded technology program emphasizing hydrogen usage. A hydrogen fueled hypersonic research airplane is essential, providing critical flight data and operational experience. (Author)

A73-22830 * **Potentials and problems of hydrogen fueled supersonic and hypersonic aircraft.** R. D. Witcofski (NASA, Langley Research Center, Hampton, Va.). In: Intersociety Energy Conversion Engineering Conference, 7th, San Diego, Calif., September 25-29, 1972, Proceedings. Washington, D.C., American Chemical Society, 1972, p. 1349-1354. 19 refs.

A73-34435 * # **Hypersonic transports - Economics and environmental effects.** R. H. Petersen and M. H. Waters (NASA, Ames Research Center, Aeronautical Missions and Technology Branch, Moffett Field, Calif.). *Journal of Aircraft,* vol. 10, June 1973, p. 334-341. 27 refs.

An economic analysis of hypersonic transports is presented to show projected operating costs (direct and indirect) and return on investment. Important assumptions are varied to determine the probable range of values for operating costs and return on investment. The environmental effects of hypersonic transports are discussed and compared to current supersonic transports. Estimates of sideline and flyover noise are made for a typical hypersonic transport, and the sonic boom problem is analyzed and discussed. Since the exhaust products from liquid hydrogen-fueled engines differ from those of kerosene-fueled aircraft, a qualitative assessment of air pollution effects is made. (Author)

A73-35469 * # **The use of hydrogen for aircraft propulsion in view of the fuel crisis.** S. Weiss (NASA, Lewis Research Center, Aerospace Safety Research and Data Institute, Cleveland, Ohio). *NASA Research and Technology Advisory Committee on Aeronautical Operating Systems, Meeting, Ames Research Center, Moffett Field, Calif., Mar. 7, 8, 1973, Paper.* 37 p. 73 refs.

In view of projected decreases in available petroleum fuels, interest has been generated in exploiting the potential of liquid hydrogen (LH2) as an aircraft fuel. Cost studies of LH2 production show it to be more expensive than presently used fuels. Regardless of cost considerations, LH2 is viewed as an attractive aircraft fuel because of the potential performance benefits it offers. Accompanying these benefits, however, are many new problems associated with aircraft design and operations; for example, problems related to fuel system design and the handling of LH2 during ground servicing. Some of the factors influencing LH2 fuel tank design, pumping, heat exchange, and flow regulation are discussed. (Author)

A73-38373 * # **Energy supply and its effect on aircraft of the future. II - Liquid-hydrogen-fueled aircraft: Prospects and design issues.** F. S. Kirkham and C. Driver (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Aircraft Design, Flight Test and Operations Meeting, 5th, St. Louis, Mo., Aug. 6-8, 1973, Paper 73-809.* 11 p. 10 refs. Members, $1.50; nonmembers, $2.00.

The performance of hydrogen-fueled commercial aircraft is

examined in the subsonic, supersonic, and hypersonic speed regime and compared with JP-fueled systems. Hydrogen aircraft are shown to provide substantial improvements in range and payload fraction as well as to minimize or eliminate many environmental problems. The major elements of a development program required to make hydrogen-fueled aircraft a commercial reality are also outlined and the rationale for and characteristics of both a subsonic demonstrator and a high speed research airplane are described. (Author)

A73-43499 * # **Potential of hydrogen fuel for future air transportation systems.** W. J. Small, D. E. Fetterman, and T. F. Bonner, Jr. (NASA, Langley Research Center, Hampton, Va.). *Intersociety Conference on Transportation, 2nd, Denver, Colo., Sept. 23-27, 1973, ASME Paper 73-ICT-104.* 11 p. 26 refs. Members, $1.00; nonmembers, $3.00.

Recent studies have shown that hydrogen fuel can yield spectacular improvements in aircraft performance in addition to its more widely discussed environmental advantages. The characteristics of subsonic, supersonic, and hypersonic transport aircraft using hydrogen fuel are discussed, and their performance and environmental impact are compared to that of similar aircraft using conventional fuel. The possibilities of developing hydrogen-fueled supersonic and hypersonic vehicles with sonic boom levels acceptable for overland flight are also explored. (Author)

N68-10726 Joint Publications Research Service, Washington, D. C.

NUCLEAR ENERGY INSTALLATIONS AND THEIR TECHNICAL POSSIBILITIES

A. I. Leypunskiy 7 Nov. 1967 12 p Transl. into ENGLISH from Kernenergie (Dresden), v. 10, no. 6, Jun. 1967 p 177–181 Presented at the Gen. Conf. of the Intern. Atomic Energy Organ., Vienna, 23 Sep. 1966

(JPRS-43265; TT-67-33889) CFSTI: $3.00

An overview is presented on the development, construction, and operation of various reactors, the prospects for constructing economical fast breeders and the problems involved, and nuclear energy programs in various countries. Among the findings reported are the following: (1) A considerable number of power plants under construction are nuclear power plants which operate with some fundamental type of thermal reactors. (2) Energy production based on nuclear energy has become an important industrial branch. (3) Operating experience with sodium-cooled fast reactors, and tests with fuel elements of uranium and plutonium dioxides indicate the feasibility of building a fast reactor which can supply cheaper electric energy than other types. M.G.J

N68-18384# Atomic Energy Commission, Washington, D. C. Div. of Industrial Participation.

THE NUCLEAR INDUSTRY

1967 184 p Presented at the Atomic Indus. Forum's Ann. Conf., Chicago, 6 Nov. 1967

(TID-24102; CONF-671115-1) GPO: $1.00

The peaceful application of nuclear energy that has the most impact on the U.S. economy is that of nuclear reactors to produce steam for generation of electric power. The volume of orders for nuclear-electric generating units for 1966 is compared with that for nine months of 1967. Other applications of nuclear energy are associated with desalting water, providing electric power for space and the ocean bottom, commercial explosives, preserving food, and producing new wood–plastic products. NSA

N68-21035*# Pennslyvania Univ., Philadelphia. Inst. for Direct Energy Conversion.

[RESEARCH IN THE CONVERSION OF VARIOUS FORMS OF ENERGY BY UNCONVENTIONAL TECHNIQUES] Status Report

Manfred Altman Dec. 1967 105 p refs

(Grant NSG-316)

(NASA-CR-93979; INDEC-SR-13) CFSTI: HC $3.00/MF $0.65 CSCL 10A

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11. PRIMARY AND SECONDARY CELLS USING CHARGE TRANSFER COMPLEXES 7 p refs

N68-25106# Goodyear Atomic Corp., Piketon, Ohio.

ENVIRONMENTAL RADIATION LEVELS AND CONCENTRATIONS Second Half and Annual Summaries, 1967

B. Kalmon and S. H. Hulett 8 Feb. 1968 16 p

(Contract AT(33-2)-1)

(GAT-553) CFSTI: HC $3.00/MF $0.65

The average environmental radiation and concentration levels for the Goodyear Atomic Corporation gaseous diffusion plant, for the second half of 1967 and for the calendar year 1967, are summarized. The results for the first half of 1967 have been previously reported but are also included in tabular form. For the second half of 1967, the water beta-gamma and the background exposure increased over the first half values. The air alpha, air beta-gamma, and the water alpha remained essentially unchanged. For calendar year 1967 versus calendar year 1966, all values remained unchanged except for the water beta-gamma value which increased significantly. However, the 1967 value is only 0.24% of the AEC concentration standard. Penetrating background dose rates remained unchanged from the 1966 values. In the calculations all of the exposure rates were assumed attributable to plant operations. As in the past, however, the off-site and on-site patterns are very much alike in form and intensity with no significant difference between average values. Based on the on-site and off-site intensities, it is evident that the plant operations have not added appreciably to the general background penetrating radiation. Author

N68-28181# Los Alamos Scientific Lab., N. Mex.

ENERGY SOURCES OF THE FUTURE WITH EMPHASIS ON THE LIGHT ELEMENTS

James L. Tuck [1967] 7 p refs Presented at the 6th IEEE Region Conf., Portland, Ore.

(Contract W-7405-ENG-36)

(LA-DC-9519; CONF-680502-2) CFSTI: HC $3.00/MF $0.65

A discussion of available power sources and their efficient application is presented. A review of fossil fuel reserves and

hydroelectric and solar energy potentials is discussed. The description and aspects of nuclear fission and fusion energies are described.
Author (NSA)

N68-28227*# Air Products and Chemicals, Inc., Allentown, Pa.
STUDY, COST, AND SYSTEM ANALYSIS OF LIQUID HYDROGEN PRODUCTION Final Report
N. C. Hallett Jun. 1968 323 p refs
(Contract NAS2-3894)
(NASA-CR-73226) CFSTI: HC$3.00/MF$0.65 CSCL 07A

This report contains information related to contemplated large-scale liquid hydrogen systems. Descriptions of feasible processes and equipment are presented. Information concerning availability and cost of required raw materials and energy are projected. Composite system analyses based on preliminary NASA hypersonic transport (HST) liquid hydrogen requirements indicate estimated average product cost of 7.7 to 8.8 cents per pound.
Author

N68-31690# North American Rockwell Corp., Los Angeles, Calif.
FRONTIERS OF TECHNOLOGY STUDY. VOLUME 3: IMPLEMENTATION
M. A. Sulkin, T. R. Parsons, and D. I. Sinizer 5 Jan. 1968 491 refs
(Contract H-779)
(PB-178272) CFSTI: HC$3.00/MF$0.65

The report describes methods used for screening technologies and selecting technological areas for implementation requirement studies; discusses current technology status, urban transportation application, advantages, disadvantages, problems associated with application, research and development requirements, gross costs, and other factors bearing on the transferability of the selected technological areas; and makes specific recommendations with regard to these areas.
Author (USGRDR)

N68-31703# North American Rockwell Corp., Los Angeles, Calif.
FRONTIERS OF TECHNOLOGY STUDY. VOLUME 2: SURVEY
M. A. Sulkin, T. R. Parsons, and D. I. Sinizer 5 Jan. 1968 266 p refs
(Contract H-779)
(PB-178271) CFSTI: HC$3.00/MF$0.65

The report documents the technology review portion of the program; describes the design of the literature review and field survey; briefly discusses the potentially transferable technologies identified; and lists sources of expertise for those technological areas.
Author (USGRDR)

N68-34388*# Stanford Research Inst., Menlo Park, Calif.
SOME MAJOR IMPACTS OF THE NATIONAL SPACE PROGRAM. 4: IMPACTS OF NEW MATERIALS TECHNOLOGY
Arthur E. Bayce Jun. 1968 63 p refs
(Contract NASw-1722; SRI Proj. MU-7227)
(NASA-CR-96813) CFSTI: HC$3.00/MF$0.65 CSCL 05C

Contributions of NASA to selected areas of materials technology and the resulting impact on the national economy were investigated through a literature search technique. All entries in STAR (Scientific and Technical Aerospace Reports) dealing with 33 selected materials areas were obtained for the period between 1962 and 1967. Technology areas that had a significant percentage of NASA reports were studied, namely electroforming; fuel cells; nickel-cadmium, silver-cadmium, and silver-zinc batteries; refractory alloys; solar cells; and stress corrosion of titanium alloys. All eight areas were considered to have impact on the power generation; all but refractory and titanium alloy research on communications; and all but silver-cadmium battery and solar cell research on transportation. Electroforming, nickel-cadmium batteries, and titanium alloys were found to have impact on health care. It was concluded that the battery, refractory alloy, and titanium alloy development had major impact; fuel cell research moderate impact; and electroforming and solar cell NASA-sponsored work had light impact on the national economy
M.W.R.

N68-35752 National Lending Library for Science and Technology, Boston Spa (England).
THE FUTURE DEVELOPMENT OF ENERGETICS
L. Melent'ev [1968] 7 p Transl. into ENGLISH from Pravda (Moscow), 12 Jul. 1968
(M-7428) Available from Natl. Lending Library, Boston Spa, Engl.

As only an estimated 25% of the potential energy contained in various forms of fuel is actually used, the scientific and technical problems connected with developing and improving the efficiency of energetics are examined. The immediate concern is seen as strengthening the base of electrification primarily by improving existing methods of producing, transmitting, and exploiting electric power. It is estimated that by the 1980's the annual increase in electric capacity in the U.S.S.R. should approximate 30 to 35 million kw. Various channels which should be explored in producing electric power are assessed, with the prediction made that a leading role will be played by the use of nuclear fuel for producing electric and possibly thermal energy; the idea of combining atomic power stations and magnetic hydrodynamic generators is mentioned. Consideration is also given to the longer-term problems which are identified as the need to seek out new sources of energy; new methods of transforming thermal, nuclear, and chemical energy into electric power; and new ways of transmitting electricity over long distances.
M.G.J.

N68-38243# Navy Dept., Washington, D. C. Translation Div.
THE ATOMIC INDUSTRY [ATOMNAYA PROMYSHLENNOST]
P. T. Astashenkov 22 Jul. 1968 227 p refs Transl. into ENGLISH from At. Prom. (Moscow), 1956 237 p
(NIC-TRANS-2653; AD-674339) CFSTI: HC$3.00/MF$0.65

In the USSR a leading atomic industry has been created and is developing successfully. This branch of production also exists in other countries of the world. In this book an attempt has been made using the materials which have been published in the Soviet and foreign press and on the basis of the achievements of Soviet and foreign technology to give an account in popular form of the most important aspects of the production picture of a modern atomic industry.
Author (TAB)

N68-38380# Environmental Science Services Administration, Idaho Falls, Idaho. Air Resources Field Research Office.
RELATIVE DOSE FACTORS FROM LONG-PERIOD POINT SOURCE EMISSIONS OF ATMOSPHERIC POLLUTANTS
George E. Start and Earl H. Markee, Jr. *In* Atomic Energy of Can., Ltd. USAEC Meteorol. Inform. Meeting 1967 p 59-76
Prepared for AEC

A new technique for estimating air pollution exposures which result from long-period effluent releases is described. A continuous point source release is approximated by sequential instantaneous point source releases. The total effluent exposure effect of the release is determined from the summed total integrated concentrations from each instantaneous point release. These exposures are expressed as a relative dose factor, the sum of hourly values of total integrated concentration (units-hr/m^3). The new method is particularly useful for calculating relative dose factors in regions in which the winds undergo a marked dirunal cycling. The maximum mixing depth concept is adopted to limit vertical dispersion. As a computational simplification, the fields of atmospheric stability and wind within the boundary layer are assumed

to have spatial homogeneity during each hourly computational interval. The technique is illustrated for a continuous, ground-level, point source release of effluent. Author (NSA)

N68-38392# Environmental Science Services Administration, Silver Spring, Md.
DIFFUSION MEASUREMENTS AT MEDIUM RANGE FROM A CONTINUOUS POINT SOURCE
Kendall R. Peterson *In* Atomic Energy of Can., Ltd. USAEC Meteorol. Inform Meeting 1967 p 252–261 Supported by AEC

The structure of the Brookhaven plume on a day with neutral stability was delineated out to distances of about 150 miles downwind from the Brookhaven reactor. A vertical cross-section at 144 n miles from the source showed the plume to be well organized with good vertical mixing giving nearly uniform maximum concentrations to at least 2000 feet. The usefulness of a vertical saw-tooth flight path was verified and is believed to be superior to a number of horizontal passes perpendicular to the plume. Peak concentrations, as observed, decrease by more than two orders of magnitude at a distance of 150 n miles and a travel time of 10 to 12 hours. Peak concentrations corrected for decay appear to decrease by about a factor of 7 to 10 over the same distance and time. The lateral standard deviation of the plume seems to fit an extension of the Pasquill-Gifford "D" curve with distance and is approximately equal in kilometers to 1.2t with time in hours. Author (NSA)

N69-12576*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
NUCLEAR REACTOR HEAT SOURCES FOR FUTURE POWER GENERATION
Samuel J. Kaufman, Donald Bogart, John V. Miller, and Richard E. Gluyas *In its* Selected Technol. for the Elec. Power Ind. 1968 p 1–34 refs
Avail: CFSTI CSCL 18L

The characteristics of the fast-breeder reactor, which seems to offer the greatest potential for the power industry, are reviewed. Experiences with reactors for space propulsion or space power systems, designed to operate at much higher temperatures and for shorter times than those of commercial power systems, are compared with information gathered from the power industry, the AEC, and their contractors. Three areas of fast-breeder reactors are discussed: (1) the difference between breeder reactors and the power reactors now in use; (2) some potential materials problems associated with breeder reactors, with emphasis on fuel elements; and (3) the relative merits of gas and liquid metal coolants for reactors. K.W.

N69-12588*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
SUMMARY OF CONFERENCE
Bernard Lubarsky *In its* Selected Technol. for the Elec. Power Ind. 1968 p 305–307
Avail: CFSTI CSCL 10B

Selected processes and equipment developed for aerospace technology are surveyed for their relevance to the electric power industry. The lower fuel cost associated with breeder reactors is considered because it will modify the balance of emphasis between efficiency, first cost, and reliability to which the power industry is currently accustomed. Smaller boilers discussed in connection with the Rankine system are feasible for use with pressurized-water or liquid-metal cooled reactors. The potential of the gas turbine in power generation is pointed out, and the advantages of a closed-cycle gas turbine coupled with a gas-cooled breeder reactor are compared with three-loop systems. Some of the control and reliability engineering techniques are considered, including automated checkout, startup, and operation. Advanced technologies of materials, bearings, seals, and instruments such as temperature sensors and torquemeters, are examined for potential industrial application. Attention is also given to cryogenic electrical components, superconductivity, and direct energy conversion by electrochemical, thermoelectric, thermionic, and magnetohydrodynamic processes. K.W.

N69-13314# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
INTERNATIONAL SYMPOSIUM ON PRODUCTION OF ELECTRIC POWER BY MEANS OF MHD GENERATORS (SELECTED ARTICLES)
14 Nov. 1968 551 p refs Transl of the book "Mezhdunarodnyy Simpozium Po Proizvodstuv Elektroenergii S Pomoshch'yu MGD Generatorov" 1966 p 1–481 Meeting Held at Salzburg, Austria, 4–8 Jul. 1966 Sponsored by Inter. Atomic Energy Agency and EURATOM
(AD-674611; FTD-HT-67-195) Avail: CFSTI CSCL 10/2

A compilation of articles on the research, development, and operation of magnetohydrodynamic generators used for electrical energy production are presented. Related papers on such topics as supersonducting magnet systems and the chemistry of various metal compounds are included. For individual titles see N69-13315–N69-13354.

N69-15807# Argonne National Lab., Ill.
CHEMICAL ENGINEERING DIVISION Semiannual Report, Jul.–Dec. 1967
May 1968 197 p refs (Contract W-31-109-eng-38)
(ANL-7425) Avail: CFSTI

Developments in research programs are presented. Included are: (1) a description of the CHEMLOC-2 computer program for calculating extent of metal–water reaction, core heating, and core motion; (2) laboratory investigations on fluorination of UO_2–PuO_2 fission products; (3) current status of investigation of neutron capture cross sections of reactor materials; (4) determination of burnup of fast reactor fuels by photometric titration; (5) compact pyrochemical processes; (6) energy conversion systems; and (7) chemical studies of irradiated ceramic fuels. F.O.S.

N69-17184 Environmental Science Services Administration, Silver Spring, Md. Air Resources Labs.
METEOROLOGY AND ATOMIC ENERGY, 1968
David H. Slade, ed. Oak Ridge, Tenn. AEC Jul. 1968 450 p refs Supported by AEC
(TID-24190) Avail: CFSTI

Studies of factors affecting radioactive atmospheric pollution are presented, and the relationship between meteorology and the nuclear industry is defined. Emphasis is placed on investigating the effects of atmospheric motions on suspended pollutants, the knowledge of which may be used in solving problems of health, safety, and economics arising from the peaceful exploitation of nuclear fission or fusion process. The role of a new field of meteorology, known as air pollution meteorology, which evolved with the development of the atomic energy industry, is discussed. Meteorological fundamentals relating to atmospheric transport and diffusion mechanisms within the lower layers of the atmosphere, an outline of theories, and a discussion of experiments on this subject are included. Atmospheric processes other than natural turbulence which affect effluent concentrations are investigated, and meteorological instruments for studying these effects, and other related phenomena, are discussed. Final topics include the concepts and techniques of radioactive cloud dose calculation and methods of environmental safety analysis. A.C.R.

N69-19492# Sandia Corp., Albuquerque, N. Mex. Aerospace Nuclear Study Dept.
THE AERIAL DETECTION OF Co-60 FUELED RADIOISOTOPE THERMOELECTRIC GENERATORS
R. J. Everett Sep. 1968 17 p refs
(Contract AT(29-1)-789)
(SC-TM-68-627) Avail: CFSTI

The aerial detection of a hypothetical ^{60}Co radioisotope thermoelectric generator is discussed for the ground level and earth and water penetration cases. A knowledge of ^{60}Co radiation fields and minimum detection levels of gamma counting equipment allowed an estimation of the detection altitude as a function of source size. Similar plots were constructed for the earth and water penetration case, using reported values for abosrption and radiation buildup. Actual detection of ^{60}Co sources in the past allowed a comparison with theoretical predictions. Author (NSA)

N69-26227# Air Force Systems Command, Wright-Pattersor AFB, Ohio. Foreign Technology Div.
A METHOD FOR DETERMINING THE ECONOMIC EFFECTIVENESS OF GAS TURBINE UNIT SYSTEMS WITH THE CONSIDERATION OF OPTIMUM PARAMETERS
F. T. Markovskii and A. F. Usik 6 Sep. 1969 14 p refs Transl. into ENGLISH from Energomashinostr. (Moscow), no. 3, 1966 p 61-67
(AD-683130; FTD-HT-23-343-68) Avail: CFSTI CSCL 21/5

A method for determining the economic effectiveness of nonregenerative gas turbine units (GTU) was developed (with consideration of the thermodynamic and engineering-economic characteristics). This method was formulated for gas turbine units which operate at rated power (for generating electricity). The costs are expressed as functions of thermodynamic parameters and economic operating conditions. The optimum combination of thermodynamic properties is determined first. Various considerations involved in designing units using expensive fuel for long periods are discussed for the case when maximum operating efficiency is the main concern. For peak units running on cheap fuel, the importance of other factors increases. When the parameters are interdependent, the problem is solved by the method of Lagrange factors; when the parameters are independent, a system of partial differential equations must be solved. Balance equations for gas turbine unit shaft operations and for compression ratios are used to reduce the interdependency of parameters and to utilize the latter method. Compression ratios affecting the investment and operating costs are studied in detail. The calculated costs are found to agree well with actual costs. A final expression is obtained for annual costs in terms of the gas turbine unit parameters. Author (TAB)

N69-36574# Royal Inst. of Tech., Stockholm (Sweden). Div. of Plasma Physics.
THE FUTURE ENERGY SUPPLY OF THE WORLD
B. Lehnert Apr. 1969 7 p refs
(Rept-69-11) Avail: CFSTI

The available data and energy consumption predictions indicate that conventional energy supplies will become insufficient during the first half of the next century and this crisis can only be avoided by the use of nuclear sources. The transition to nuclear power is discussed and it is shown that research and development of breeder and/or fusion reactors should be intensified. ESRO

N69-38723*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
THE POTENTIAL OF NUCLEAR POWER FOR HIGH-SPEED OCEAN-GOING AIR-CUSHION VEHICLES
Frank E. Rom and Albert F. Kascak Washington Sep. 1969 34 p refs
(NASA-TM-X-1871) Avail: CFSTI CSCL 21F

The use of nuclear powerplants based on nuclear aircraft technology to power ocean-going air-cushion vehicles has been investigated. Because aircraft nuclear powerplants might be an order of magnitude lighter than current nuclear marine plants, the performance of nuclear air-cushion vehicles is dramatically altered. Instead of vehicles limited to short ranges and speeds of about 80 knots, they become vehicles with virtually unlimited range and speeds in the range of 100 to 200 knots. The study considers vehicles with gross weights of 1000 to 10,000 tons and clearance heights from 10 to 40 feet, which are sufficient to clear ocean waves 80 to over 90 percent of the time. The cargo capacity ranges from 20 to 50 percent of the gross weight. Direct operating costs are 2 to 5 cents per ton-mile and are independent of the distance travelled. Author

N69-39189*# Wayne State Univ., Detroit, Michigan. Center for Application of Sciences and Technology.
APPLYING NASA TECHNOLOGY TO AIR POLLUTION: THE SULFUR DIOXIDE PROBLEM, SECTION 2 Final Report
[1969] 27 p refs Revised Supersedes X69-14671
(Contract NSR-23-006-044)
(NASA-CR-100629) Avail: CFSTI CSCL 13B

After a broad review of the characteristics of the air pollution problem, the reduction of sulfur oxides from fuel oils, flue gases, and coal is discussed. The use of fuel cells and solid state devices in commercial electric power generation is considered. Technical and legislative solutions to the sulfur dioxide problem are explored along two lines: (1) the Kaldor Criterion, or net benefit to the system, with gains of one group offsetting losses of another group; and (2) the Pareto Optimality, i.e., no sacrifices on the part of anyone. As an example of (1), the liquefaction of coal for electric power generation is discussed; as an example of (2), the use of nuclear power plants for high-voltage dc power generation is mentioned. K.W.

N70-14504# Atomic Energy Commission, Oak Ridge, Tenn. Technical Information Div.
ABUNDANT NUCLEAR ENERGY
May 1969 347 p refs Presented at the Proc. of a Symp., Gatlinburg, Tenn., 26 29 Aug. 1968
Avail: CFSTI

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18. NUCLEAR DESALTING C. C. Burwell (Oak Ridge Natl. Lab., Tenn.) p 299–312 refs

N70-14505# Oak Ridge National Lab., Tenn.

RATIONALE FOR LOW COST NUCLEAR HEAT AND ELECTRICITY

James A. Lane *In* AEC Abundant Nucl. Energy May 1969 p 3–28 refs

Avail: CFSTI

It is projected that the average delivered cost of electricity in the United States will decrease to 3.5 mills/kw-hr and the per capita consumption will increase to 30,000 kw-hr per annum in 2000 AD. Achieving such low-cost power will require significant improvements in generating costs, as well as reductions in transmission and distribution costs. Details of how this might be done are described. Generating costs, for example, will be reduced to about 1.5 mills/kw-hr through the development of very large (i.e., 5000-Mw(e)) high-performance breeders served by large-scale fabrication and processing plants. If the sale price of electricity is properly assigned to various types of customers as a function to the amount used by each customer, an average delivered price of 3.5 mills/kw-hr would result in a rate of 5.5 mills/kw-hr for residences and 1.5 mills/kw-hr for industries. Author (NSA)

N70-14506# Oak Ridge National Lab., Tenn.

ENERGY INTENSIVE AND HEAT INTENSIVE PROCESSES FOR A NUCLEAR ENERGY CENTER

John M. Holmes *In* AEC Abundant Nucl. Energy May 1969 p 29–43 refs

Avail: CFSTI

Chemical and metallurgical industries are large energy consumers with increasing power demands and significant sensitivities to changes in electricity prices. The major categories considered for installation at nuclear energy centers include: balanced fertilizers; metals, such as aluminum, iron, steel, and magnesium; plastics; and brine chemicals. Other energy-intensive systems that may show promise include waste-water treatment, electric railways, high-temperature process heating, urban space heating, and several recently developed electroorganic processes. For economic utilization of the power from a 1000-Mw(e) nuclear reactor, a number of the proposed systems would have to be combined into a complex. Author (NSA)

N70-14519# Oak Ridge National Lab., Tenn.

APPLICATION OF LOW-COST ENERGY TO PROCESSING OF SEWAGE WATER FOR REUSE

Irving Spiewak *In* AEC Abundant Nucl. Energy May 1969 p 239–247 refs

Avail: CFSTI

Water supply and sewerage systems for a city of 2 million are analyzed. Examples are given of a conventional system, a system using advanced waste treatment, and a system using complete waste-water recycle. Low-cost energy has a significant impact only on the water recycle systems, which includes a unique desalting process combining electrodialysis and distillation. Waste solids are distilled to dryness. The cost of the total water system ranges from \$0.33/1000 gal for the conventional system to \$0.45/1000 gal for the water recycle system. Author (NSA)

N70-21569# Edison Water Quality Lab., N.J.

BIOLOGICAL EFFECTS OF OIL POLLUTION: BIBLIOGRAPHY. A COLLECTION OF REFERENCES CONCERNING THE EFFECTS OF OIL ON BIOLOGICAL SYSTEMS

Donna R. Radcliffe and Thomas A. Murphy Oct. 1969 52 p refs

(Contract DAST-19W70-02038)

(PB-188206) Avail: CFSTI CSCL 06F

References on the biological effects of oil are listed according to the following categories: Publications on the general aspects of oil pollution, reports of oil spill incidents, general biological effects of oil and of specific oil spill incidents, effects of oil on birds, effects of oil on fish, effects of oil on shellfish, effects of oil on freshwater invertebrates, effects of oil on plants, effects of oil on dissolved oxygen, carcinogenic effects of oil, and miscellaneous biological reports on oil. Author (USGRDR)

N70-25747# Nossaman, Waters, Scott, Krueger, and Riordan, Los Angeles, Calif.

STUDY OF OUTER CONTINENTAL SHELF LANDS OF THE UNITED STATES. VOLUME 1: INTRODUCTION, CHAPTERS 1 AND 2

Nov. 1969 289 p refs Sponsored by the Public Land Law Rev. Comm. Revised

(PB-188714) Avail: CFSTI CSCL 05C

Contents: Introduction: Legal aspects (International considerations, Allocation of federal jurisdiction over activities on or affecting the outer continental shelf, Background of the Submerged Lands Act and Outer Continental Shelf Lands Act, Administration of the Outer Continental Shelf Lands Act); Resource aspects (Known and potential resources of the outer continental shelf, Living resources of the continental shelf, Anticipated development of offshore mineral industry and technology. Economic analysis of leasing experience under the Outer Continental Shelf Lands Act, An economic analysis of prorationing of production) USGRDR

N70-25748# Nossaman, Waters, Scott, Krueger, and Riordan, Los Angeles, Calif.

STUDY OF OUTER CONTINENTAL SHELF LANDS OF THE UNITED STATES. VOLUME 2: CHAPTERS 3 THROUGH 7

Nov. 1969 336 p refs Sponsored by the Public Land Law Rev. Comm. Revised

(PB-188715) Avail: CFSTI CSCL 05C

Contents: Background of the submerge lands act and outer continental shelf lands act; Administration of the outer continental shelf lands act; Living resources of the continental shelf; Anticipated development of offshore mineral industry and technology. Author (USGRDR)

N70-25749# Nossaman, Waters, Scott, Krueger, and Riordan, Los Angeles, Calif.

STUDY OF OUTER CONTINENTAL SHELF LANDS OF THE UNITED STATES. VOLUME 3: CHAPTERS 8 THROUGH 12

Nov. 1969 249 p refs Sponsored by the Public Land Law Rev. Comm. Revised

(PB-188716) Avail: CFSTI CSCL 05C

Contents: Economic analysis of leasing experience under the Outer Continental Shelf Lands Act; An economic analysis of prorationing of production; User interaction and environmental impact; Analysis of the existing system of administration of outer continental shelf lands; Analysis of alternatives to existing system. USGRDR

N70-25750# Nossaman, Waters, Scott, Krueger, and Riordan, Los Angeles, Calif.

STUDY OF OUTER CONTINENTAL SHELF LANDS OF THE UNITED STATES. VOLUME 4: APPENDICES

Nov. 1969 397 p refs Sponsored by the Public Land Law Rev. Comm. Revised

(PB-188717) Avail: CFSTI CSCL 05C

Contents: Truman proclamation; Convention on the continental shelf; Convention on the territorial sea and the contiguous zone; Convention on the high seas; Convention on fishing and conservation of the living resources of the high seas; Public Law 89-658; 80 Stat. 908 fishery zones – extra-territorial sea; Marine Resources and Engineering Development Act of 1966; A discussion of the legislative history and possible construction of the Convention on the Continental Shelf; U.N. resolution establishing the Ad Hoc Committee to study peaceful uses of the sea-bed and the ocean floor beyond the limits of national jurisdiction; Proposal of the permanent Mission of Malta; Draft resolution of United States to Ad Hoc Committee; Submerged Lands Act; Outer Continental Shelf Lands Act; Regulations - Bureau of Land Management; Regulations - U.S. Geological Survey; Exchange of correspondence between the Department of the Interior and the Department of the Army regarding review of applications for permits; Potential Mineral Resources of the United States Outer Continental Shelf; Report of the Secretary General to the United Nations Economic and Social Council on the Resources of the Sea. USGRDR

N70-25751# Nossaman, Waters, Scott, Krueger, and Riordan, Los Angeles, Calif.

STUDY OF OUTER CONTINENTAL SHELF LANDS OF THE UNITED STATES. VOLUME 5: APPENDICES

Nov. 1969 399 p refs Sponsored by the Public Land Law Rev. Comm. Revised

(PB-188718) Avail: CFSTI CSCL 05C

Contents: Bibliography and source list; Questionnaire to industries; Notices concerning oil and gas leasing; Summaries of salt water angling and collisions involving offshore structures; Work statement; Comparative laws and policies (domestic). USGRDR

N70-25752# Nossaman, Waters, Scott, Krueger, and Riordan, Los Angeles, Calif.

STUDY OF OUTER CONTINENTAL SHELF LANDS OF THE UNITED STATES. VOLUME 6: APPENDICES

Nov. 1969 220 p refs Sponsored by the Public Land Law Rev. Comm. Revised

(PB-188719) Avail: CFSTI CSCL 05C

Contents: Offshore mineral leasing experiences of coastal states; Comparative laws and policies (foreign); Compilation of alternatives; Department of the Interior reports. USGRDR

N70-34670# National Air Pollution Control Administration, Washington, D.C.

CONTROL TECHNIQUES FOR SULFUR OXIDE AIR POLLUTANTS

Jan. 1969 144 p refs

(PB-190254; AP-52) Avail: SOD $1.25; CFSTI CSCL 13B

The document reports the major sources of sulfur oxide air pollution, and discusses the control techniques for fuel combustion processes, industrial processes, and dispersion from stacks as found in many industries. USGRDR

N70-36154# Congress. House. Committee on Interstate and Foreign Commerce.

AIR POLLUTION CONTROL RESEARCH INTO FUELS AND MOTOR VEHICLES

Washington GPO 1969 127 p refs Hearing on H.R. 12085 before Comm. on Interstate and Foreign Com., 91st Congr., 1st Sess., 19 Jun. 1970 *Its* Serial 91-17

Avail: Subcomm. on Public Health and Welfare

Statements and reports on air pollution control program activities, current and projected research, and environmental problems are presented. Abatement activities and data pertaining to motor vehicle, aircraft engine, and diesel engine exhausts, and industrial wastes are discussed. Air pollution abatement by federal facilities is also covered. N.E.N.

N70-37081# Atomic Energy Commission, Washington, D.C. Div. of Research.

THE FUSION TORCH: A NEW APPROACH TO POLLUTION AND ENERGY USAGE

Bernard J. Eastlund and William C. Gough 7 Nov. 1969 27 p refs Presented at 62d Ann. Meeting on Waste Treatment Appl. of Radiation Chem., Washington, D.C., 16-20 Nov. 1969

(Conf-691108-2) Avail: CFSTI

A new concept is described for the handling of large volumes of solid wastes in the future. The energy and material balance for processing U. S. municipal wastes in the year 2000 via this concept is compared with that for advanced incineration. Background discussion of the properties of a fusion plasma and a future fusion power system are given. Author (NSA)

N70-37097# Oak Ridge National Lab., Tenn.

PRELIMINARY APPRAISAL OF THE HAZARDS PROBLEMS OF A D-T FUSION REACTOR POWER PLANT

A. P. Fraas and H. Postma May 1970 32 p refs

(Contract W-7405-eng-26)

(ORNL-TM-2822) Avail: CFSTI

A preliminary assessment of the hazards problems of a D–T fusion reactor was made to provide some notion of the seriousness of these problems in possible future applications of thermonuclear power plants. The inherent characteristics of magnetically confined plasmas appear to be such that any tendency toward general power overshoots or local hot spots will be more than compensated by other factors, so that there should be no difficulties with either general or local temperature or power excursions that might cause a meltdown or an explosion. In turning to radiological hazards, the principal source of concern is tritium. Fortunately, fusion reactor systems will ordinarily be designed so that the bulk of the tritium produced will be consumed as fuel. Thus, though the tritium production rate will run roughly 1000 times that in a fission reactor, by proper plant design the tritium inventory can be kept to about the same level as in a conventional fission reactor such as a PWR. Author (NSA)

N70-37343# Battelle Memorial Inst., Richland, Wash. Pacific Northwest Labs.

A REVIEW AND COMPARISON OF SELECTED UNITED STATES ENERGY FORECASTS

Dec. 1969 96 p Prepared for the Executive Office of the President, Office of Sci. and Technol.

(PB-189938) Avail: $1.00; CFSTI CSCL 05A

The report collects in a single volume the essence of nineteen energy forecasts published in recent years by private organizations, government agencies, and individuals and compares their forecast values, assumptions, and methodologies. The study evaluates existing energy forecasts for policy planning purposes. The forecasts were prepared for different purposes and often reflect differences in terminology, coverage, and assumptions. The comparative tables in the report take these differences into account insofar as possible. USGRDR

N70-37672# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
THE ENERGY SOURCES OF AVIATION ENGINES
Pin-Chuan Chang 15 May 1970 8 p Transl. into ENGLISH from Hang K'ung Chih Shih (Communist China), no. 7, 1960 p 16
(AD-707178; FTD-HT-23-213-70) Avail: CFSTI CSCL 21/4

After reviewing the properties and limitations of chemical fuels such as gasoline, solid fuel and hydrogen fuel, the report discusses the possibilities of ionic fuel and nuclear fuel, and their existing problems of application to aviation. It is stressed that due to the fast scientific progress and requirements, these pending problems may soon be solved. Author (TAB)

N70-39315# California Univ., Berkeley.
THE FUTURE OF VEHICULAR POWER PLANTS
Ernest S. Starkman *In* Ariz. Univ. Proc. of Air Pollution Control Seminar 13 Feb. 1970 p 12-52 refs

Avail: NTIS

The automobile is discussed with relation to its comparative role in air pollution, including the pollutants contributed and their effects. Revisions in engine operation to reduce air pollution are mentioned, and it is noted that as the levels of carbon monoxides and unburned hydrocarbons were being lowered, nitrogen oxide levels increased. Federal and state controls are described, and future air quality is predicted. The slow rate at which pollution control can be realized through the modification of new vehicles alone is suggested. Powerplants possible for automobiles other than internal combustion engines are described, including the electric vehicle and associated problems, steam engines, gas turbines, Wankel and Stirling engines, and engines using natural gas as fuel. Accomplishments in pollution reduction due to conventional engine controls are discussed, and past and future relative pollutant production from automobiles is compared with that from stationary sources. Graphs illustrate the presentation, and a bibliography is included. P A B.

N70-41770# Congress. Senate. Committee on Public Works.
AIR POLLUTION: 1970, PART 3
Washington GPO 1970 294 p refs Joint hearings on S. 3229, S. 3466, and S. 3546 before Comm. on Public Works and Comm. on Com., 91st Congr., 2d Sess., 24-25 Mar. 1970 Prepared by Subcomm. on Air and Water Pollution of the Comm. on Public Works and the Comm. on Com.
Avail: SOD $1.25

Noise pollution, its effects on man and animals, and possible abatement legislation are discussed. Other topics include wheat for motor fuel, airline antipollution measures, automobile exhaust emission and the position of the auto industry, the effect of gasoline composition and associated research and development, and toxicological problems associated with lead. P.A.B.

N70-41771# Congress. Senate. Committee on Public Works.
AIR POLLUTION: 1970, PART 4 From the Subcommittee on Air and Water Pollution
Washington GPO 1970 300 p refs Hearings on S. 3229, S. 3466, and S. 3546 before Comm. on Public Works, 91st Congr., 2d Sess., 26 Mar., 17 Apr., and 27 May 1970; also in Los Angeles, 1 Apr.
Avail: SOD $1.50

Information on California air basins, standards for exhaust emissions, and ambient air quality standards is presented. National air quality standards are then discussed, including automobile emission reduction, industrial processes, metropolitan areas, and the proposed amendments to the Clean Air Act. Data are presented on the ability of gas additives to clean engines and reduce exhaust emissions, and on specific research concerning the effects of the Chevron F-310 gas additive package. Methods to prevent and control air pollution build-up are described, and the guidelines for air pollution planning grants are presented. P.A.B.

N71-13756# Kernforschungszentrum, Karlsruhe (West Germany). Inst. fuer Angewandte Reaktorphysik.
AN APPROACH TO COMPARE AIR POLLUTION OF FOSSIL AND NUCLEAR POWER PLANTS
P. Jansen, S. Jordan, and W. Schikarski 1969 18 p refs Presented at Symp. on Environ. Aspects of Nucl. Power Sta., New York, 10-14 Aug. 1970
(Conf-700810-20; SM-146/57) Avail: AEC Depository Libraries

The possible air pollution of fossil and nuclear power plants is discussed. Since the emissions of fossil and nuclear power plants are different in nature and effect on the environment, the comparison of the air pollution of power plants is difficult. This is mainly due to the fact that fossil power plants pollute air by the emission of reactive gases (i.e., sulphur oxides) and smoke (aerosols) whereas nuclear power plants could emit radioactive gases (i.e., fission gases) and radioactive aerosols which affect the environment in a different way. A study has been carried out to compare air pollution of both nuclear and fossil fuelled power plants. Two models have been used in the study. The first was developed on the basis of the maximum permissible concentrations set by biophysical and medical bodies for the various pollutants. The second model used the fact that excessive burdens by the various pollutants to the surrounding population lead statistically to a certain number of cases of illness or death. Author (NSA)

N71-23353# Office of Naval Research, London (England).
SEVENTH INTERNATIONAL POWER SOURCES SYMPOSIUM, BRIGHTON, SUSSEX, 15-17 SEPTEMBER 1970
Alfredo Banos, Jr. 20 Jan. 1971 11 p refs Held at Brighton Sussex England, 15-17 Sep. 1970
(AD-718833; ONRL-C-1-71) Avail: NTIS CSCL 10/2

The report gives an analysis of the nations represented, and a full account of the papers according to: (a) nature of the paper, whether research, development, production and testing, or applications; (b) the type of contributing institution, and (c) the subject matter itself, and concludes with general remarks on the highlights of meeting. The appendix contains a complete list of the papers presented. Author (GRA)

N71-26623# Joint Publications Research Service, Washington, D.C.
GLOBAL CONTAMINATION OF THE ATMOSPHERE BY KRYPTON-85 FROM WORLD WIDE NUCLEAR POWER PLANTS AND THE RADIATION DANGER
I.L. Karol et al 20 May 1971 17 p refs Transl. into ENGLISH of the publ. 'Globalnoye Zagryazneniye Atmosfery Kriptonom-85 ot Mirovoy Yadernoy Energetiki i Yego Radiatsionnaya Opasnost' Obninsk, Inst. of Exptl. Meteorology p 1-25
(JPRS-53174) Avail: NTIS

The annual mean and zonally averaged concentration of krypton-85 in the troposphere and lower stratosphere of the Northern and Southern hemispheres are calculated. The calculations are based on a numerical deviation of a global spread of the admixture in a meridional plane of the atmosphere. The results of the calculations with various combinations of the transfer parameters of the model are compared with the results of measurements in the U.S. and abroad. Predicted distributions of the expected levels of the gas were obtained up to the year 2,000. The corresponding radiation dose strengths in the air for the whole body and for individual organs of the human body were also calculated. These dose strengths and concentrations are compared with the maximum allowable levels which were established on the basis of the current recommendations of the International Commission for Radiological Defense and Medical Rules. Author

N71-29471# Committee on Public Works (U.S. Senate).
SOME ENVIRONMENTAL IMPLICATIONS OF NATIONAL FUELS POLICIES

Washington GPO 1970 74 p refs Presented by Comm. on Public Works, 91st Congr., 2d Sess., Dec. 1970
Avail: SOD $0.30

An objective analysis of the factors relevant to the development of fuels and energy policies compatible with environmental quality requirements is presented as a staff report to the Chairman of the Committee on Interior and Insular Affairs. Based on the expected population growth, the energy and fuel requirements are projected to the year 2000. Techniques and processes for pollution control are discussed, and the expenditures for pollution research are summarized for FY 1969, 1970, and 1971. F.O.S.

N71-29607*# General Electric Co., Philadelphia, Pa.
H2 FUEL SYSTEM INVESTIGATION
W. Collier *In* NASA. Marshall Space Flight Center Proc.: Space Transportation System Propulsion Technol. Conf., Vol. 3 28 Apr. 1971 p 1191 1224
Avail: NTIS CSCL 21I

Progress in designing and developing an air breathing engine system for space shuttle application is reported. Tasks included a parametric evaluation of various engine cycles employing hydrogen fuel; an engine design study; engine development plan and cost estimate; and performance specification. All work is completed, and a derivative of the F-101 engine was recommended and used as the referenced engine. While the hydrogen versus jet propulsion fuel evaluation is not yet complete, it appears that the use of hydrogen requires additional development in the fuel handling system and related control and accessory areas. No basic technological barriers were identified, however, for fitting an engine of this type to the desired application. A.C.R.

N71-31900# Battelle Memorial Inst., Columbus, Ohio.
THE FEDERAL R AND D PLAN FOR AIR POLLUTION CONTROL BY COMBUSTION-PROCESS MODIFICATION Final Report
11 Jan. 1971 352 p refs
(Contract CPA-22-69-147)
(PB-198066; APTD-0643) Avail: NTIS HC $6.00/MF $0.95 CSCL 13B

Results are reported of a study conducted for the Air Pollution Control Office to (1) identify gaps in combustion technology and (2) recommend a 5-year plan with priorities for effectively allocating resources for APCO supported combustion R and D directed toward meeting projected needs for air pollution control of energy conversion system by combustion modification. Combustion applications considered as elements of the plan include: central station power generation; industrial processing; industrial steam generation, commercial and residential heating; gas turbines and external combustion engines; and reciprocating internal combustion engines. A 5-year plan of combustion R and D is presented, with R and D opportunities identified and ranked in five priority levels. GRA

N71-32624# Coast Guard, Washington, D.C.
OIL POLLUTION LIABILITY AND FINANCIAL RESPONSIBILITY. A REPORT TO THE PRESIDENT AND THE CONGRESS Final Report
Dec. 1970 25 p
(PB-198775; USCG-OIL-70-1) Avail: NTIS

The report summarized a study on the need for measures to provide financial responsibility and limitation of liability for vessels, onshore and offshore facilities for costs of removing discharged oil and payment of damages resulting from the discharge. The report recommends to the President and the Congress no change in liability for vessels, federal preemption for vessels in interstate commerce, and that varying schedules of proof of financial responsibility of onshore and offshore facilities be established based on the pollution potential of the facility. GRA

N71-32625# George Washington Univ., Washington, D.C.
LEGAL, ECONOMIC, AND TECHNICAL ASPECTS OF LIABILITY AND FINANCIAL RESPONSIBILITY AS RELATED TO OIL POLLUTION Final Report
Dec. 1970 347 p refs
(Contract DOT-CG-10255-A)
(PB-198775; USCG-OIL-70-2) Avail: NTIS HC $6.00/MF $0.95 CSCL 13B

An intensive study of the oil pollution problem in its legal, economic and technical aspects is presented. The contents include the following: Analysis of the water quality improvement act; Theories of liability and their relation to oil pollution; Potential problems of the act; Jurisdiction; Economic principles of liability and financial responsibility for oil pollution; Oil pollution prevention and carrier liability; Economic models for analysis of problems; Relationships between cleanup costs and quantity of oil spilled; Measures of the potential economic loss from pollution; International trade implications of U.S. policies; The nature, behavior, and ecological effects of oil spills; Method for containment and cleanup of oil spills; and Oil pollution prevention and the characteristics of the oil industry production, transporting, and storage facilities. GRA

N71-33879# International Atomic Energy Agency, Vienna (Austria).
NUCLEAR ENERGY AND THE ENVIRONMENT Addendum to the Agency's Report to the Economic and Social Council of the United Nations for 1969 – 1970
[1970] 20 p refs
(INFCIRC/139/Add-1) Avail: NTIS

The application of nuclear energy to meet the power demands of an increasing population is discussed. The reduction in air pollution and improvement in environmental conditions is considered. The technology for containment and disposal of radioactive wastes is reported. Author

N71-35176# Atomic Energy Commission, Washington, D.C.
ENVIRONMENTAL CONSIDERATIONS IN THE REGULATORY PROCESS FOR PLANTS IN THE U.S.: THE ROLE OF THE PUBLIC AND PUBLIC UNDERSTANDING
James T. Ramey 13 Aug. 1971 25 p refs Presented at the Intern. Atomic Energy Agency Symp. on Environ. Aspects of Nucl. Power Plants, N. Y., 13 Aug. 1970
(IAEA-SM-146/5) Avail: NTIS

The proceedings of a conference on the licensing and control of nuclear power plants are presented. Subjects discussed are: (1) growth of electric power needs, public participation in regulatory procedures for nuclear reactor use, (3) reactor licensing, and (4) international cooperation. P.N.F.

N72-11844*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
WHAT CAN NUCLEAR ENERGY DO FOR SOCIETY?
Frank E. Rom Nov. 1971 24 p refs Presented at the 2nd Uranium Plasma Symp., Atlanta, 15-17 Nov. 1971; Sponsored by Am. Inst. of Aeron. and Astronautics
(NASA-TM-X-67963; E-6674) Avail: NTIS CSCL 05K

The utilization of nuclear energy and the predicted impact of future uses of nuclear energy are discussed. Areas of application in electric power production and transportation methods are described. It is concluded that the need for many forms of nuclear energy will become critical as the requirements for power to supply an increasing population are met. P.N.F.

N72-11848# Oak Ridge National Lab., Tenn.
THE ENVIRONMENT AND TECHNOLOGY ASSESSMENT Progress Report, Jun.-Dec. 1970
Feb. 1971 251 p refs
(Contract W-7405-eng-26; NSF Order AAA-R-4-79)
(ORNL-NSF-EP-3) Avail: NTIS

A study of electrical energy consumption patterns, processes, and economics in highly developed countries is presented. The relationship between consumption of non-renewable resources and environmental degradation which occurs with an increase in energy consumption is discussed. Serious questions about the desirability as well as the practicality of continuing current patterns of energy consumption and growth are examined. Author

N72-13391*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
FIFTH AEROSPACE MECHANISMS SYMPOSIUM
Washington 1971 196 p refs Proceedings of conf. held in Greenbelt, Md., 15-16 Jun. 1970; sponsored by NASA. Goddard Space Flight Center, Santa Clara Univ., and Lockheed Missiles and Space Co.
(NASA-SP-282) Avail: NTIS CSCL 13I

Structural design principles and mechanical engineering methods in developing various types of aerospace mechanisms used in orbital and space flights are reported. Topics include descriptions of an electromechanical docking mechanism attenuator, of various nutation dampers, and of numerous mechanical spacecraft subsystems.

N72-13956# Royal Swedish Academy of Engineering Sciences, Stockholm.
SWEDISH RESEARCH ON ENERGY AND ITS GLOBAL RELATIONSHIP
In its Develop. in Res. and Technol. during 1970 1970 p 116-150 refs In SWEDISH (See N72-13942 04-34)
Avail: NTIS; Almqvist & Wiksell, Stockholm: 25 Kr

N72-16982# United Nations, New York. Dept. of Economic and Social Affairs.
WORLD ENERGY REQUIREMENTS AND RESOURCES IN THE YEAR 2000
Jul. 1971 21 p refs Presented at the 4th Intern. Conf. on the Peaceful Uses of Atomic Energy, Geneva, 6-16 Sep. 1971
(A/Conf-49/P-420; Conf-710901-439) Avail: AEC Depository Libraries

Existing long-term projections of energy demand at global and regional levels are reviewed. Long term factors influencing the demand for energy in countries in various stages of socio-economic development are assessed. Likely shifts in the demand for energy over the long term period in the light of various assumptions relating, among others to prospective economic growth rates, and to technological changes and innovations that may produce major shifts in the long term pattern of energy consumption are identified. Author (NSA)

N72-20371# Brookhaven National Lab., Upton, N.Y.
ECOLOGICAL EFFECTS OF ENERGY: A BASIS FOR POLICY IN REGIONAL PLANNING
G. M. Woodwell and C. A. S. Hall [1971] 15 p refs
(BNL-16228) Avail: NTIS

The ecological effects of energy and establishment of a basis for policy in regional planning are discussed. It is determined that the maintenance of the physical, chemical, and biotic integrity of the environment, regionally and earth wide, is a major consideration in planning any human activity and especially in planning for energy. Stability is an objective because the alternative, progressive degradation of the environment, is unacceptable. A wide spectrum of new laws governing the ecology may be required to produce the desired results. Author

N72-20948# RAND Corp., Santa Monica, Calif.
SIGNED DIGRAPHS AND THE GROWING DEMAND FOR ENERGY
Fred S. Roberts May 1971 62 p refs
(Grant NSF GI-44)
(R-756-NSF) Avail: NTIS

An outline is given of a methodology which exploits the signed digraph for handling problems of forecasting energy demand and the effect of new technologies and institutions on that demand, and for generating and analyzing policy alternatives for meeting environmental constraints on energy use. The forecasting and policy problems are translated into signed digraph problems, and in particular to problems of so-called pulse processes on signed digraphs. Research problems related to the development of the methodology are described. Author

N72-23948# Committee on Science and Astronautics (U. S. House).
AN INVENTORY OF ENERGY RESEARCH, VOLUME 1
Washington GPO 1972 1110 p refs Presented to the Comm. on Sci. and Astronaut., 92d Congr., 2d Sess., 20 Feb. 1972
Avail: Subcomm. on Sci, Res., and Develop.

Evaluated are the needs of the United States of America for research and development related to the generation, transmission and utilization of energy. Considered are: general fossile fuels, coal, petroleum, natural gas, nuclear, plasma, hydraulic, solar, geothermal, wind, wood and other biological, chemical, and unspecified energy sources. G.G.

N72-25635# Oak Ridge National Lab., Tenn.
AN INVENTORY OF ENERGY RESEARCH, VOLUME 1
Jan. 1972 641 p refs Prepared for NSF, Wash., D. C.
(Contract W-7405-eng-26)
(ORNL-EIS-72-18-Vol-1) Avail: NTIS

Approximately 4400 research projects are listed by title under one of 14 categories of energy sources. These categories are: fossil fuels, general; coal; petroleum; natural gas; nuclear, general; nuclear fission; nuclear fusion and plasmas; hydraulic; solar; geothermal; wind; wood and other biological; chemical; and unspecified energy sources. Each of the 14 categories of energy sources is divided into eight stages for each source, starting with exploration, continuing through mining and extraction, concentration and refining, transportation, storage, conversion, distribution, and ending with use. Each of these eight stages is, in turn, subdivided into the six following fields of research: basic research; engineering development; economic; environmental; legislative/ regulatory; and historical. NSA

N72-25929# Committee on Science and Astronautics (U. S. House).
BRIEFINGS, BEFORE THE TASK FORCE ON ENERGY OF SUBCOMMITTEE ON SCIENCE, RESEARCH, AND DEVELOPMENT, VOLUME 2
Washington GPO 3 May 1972 185 p refs Presented to the Comm. on Sci. and Astronaut., 92d Congr., 2d Sess., 28 Mar. 1972
Avail: Subcomm. on Sci., Res., and Develop.

Briefings are presented on energy sources, resources, and research. Topics considered include the management and use of energy resources, transmission systems and networks, analysis and synthesis of energy systems, research opportunities and energy research needs, nuclear power, coal gasification, optimum uses of energy sources, and satellite solar power stations and power generation. K.P.D.

N72-25931# Committee on Science and Astronautics (U. S. House).
AN INVENTORY OF ENERGY RESEARCH
Washington GPO Mar. 1972 631 p Presented to Comm. on Sci. and Astronaut., 92d Congr., 2d Sess., Mar. 1972 Sponsored by NSF Prepared by ORNL for Task Force on Energy of Subcomm. on Sci., Res., and Develop.
Avail: Subcomm. on Sci., Res., and Develop.

The indexes for Volume 1 are presented and include: simple

index on research institutes, simple index on sponsors, simple index on principal investigators, and permuted index on titles.
F.O.S.

N72-26971*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
ENERGY IN THE ENVIRONMENT AND THE SECOND LAW OF THERMODYNAMICS
Robert F. Mueller May 1972 9 p refs Submitted for publication
(NASA-TM-X-65912; X-644-72-130) Avail: NTIS HC $3.00 CSCL 20M

The relationship between the consumption of energy by technological cultures and the second law of thermodynamics is discussed. The analysis is based on a description' of the operation of a mechanical device which consumes energy. It is concluded that the flow of energy in manifold spontaneous conditions, which play a vital role in the operation of any technological process, remove most of the energy flow path from the control of the operator. It is stated that the increased efficiency of a process can benefit the environment only as much as this efficiency enables the total energy input to be reduced for a given level of production and increasing efficiency cannot meet the problems of an increased rate of energy utilization. Author

N72-30977# Committee on Interior and Insular Affairs (U. S. Senate).
ADVANCED POWER CYCLES
Washington GPO 1972 279 p refs Hearing pursuant to S. Res. 45 before Comm. on Interior and Insular Affairs, 92d Congr., 2d Sess., 8 Feb. 1972
Avail: Comm. on Interior and Insular Affairs

The hearings are reported concerned with new technologies for the environmentally acceptable generation of electricity from coal. The processes for the gasification of coal, and the problem in the removal of sulfur compounds are discussed. Summaries of the EPA activities in compliance with the Clean Air Act are included. F.O.S.

N73-10980# Committee on Science and Astronautics (U. S. House).
BRIEFINGS BEFORE THE TASK FORCE ON ENERGY OF THE SUBCOMMITTEE ON SCIENCE, RESEARCH, AND DEVELOPMENT, VOLUME 2
Washington GPO Mar. 1972 185 p refs Briefings held in Oct. and Nov. 1971 presented to the Comm. on Sci. and Astronaut., 92d Congr., 2d Sess., 21 Mar. 1972
Avail: Subcomm. on Sci., Res., and Develop.

The hearings concerning the research and development requirements for future national energy needs are reported. The optimal application of technology for the conservation of minerals, and the enhancement of environmental resources are discussed invluding: (1) power siting methodology, (2) utilization and disposition of rejected heat, (3) emissions reduction and management, (4) resources exploration and development methodology, and (5) efficient use of energy. Fast breeder reactors, solar arrays, and coal gasification are discussed as energy sources. F.O.S.

N73-12707# Nowak (K.), Vienna (Austria).
PROJECT FOR OBTAINING CONTROLLED NUCLEAR FUSION. A NEW SYSTEM THAT SHOULD LEAD TO RAPID PRACTICAL USE FOR ENERGY PRODUCTION BY CONTROLLED NUCLEAR FUSION
K. Nowak [1972] 16 p refs In GERMAN
(NP-19152) Avail: AEC Depository Libraries

The method described should make possible the technical evaluation of controlled nuclear fusion with positive energy balance and high efficiency for the energy production and, by creation of defined ratios, avoid the origin of neutron or tritium emission. For this method, the brief collision of plasmas of high ion density formed from accelerated deuterium ions and electrons was proposed. The selected pulse times and accelerations permit the greatest possible efficiency of the fusion process. The bias against obtaining controlled nuclear fusion by collision of accelerated ions was based on the previous ratios for pure ion beams of usual plasma densities, but is erroneous for plasma beams of high density. Author (NSA)

N73-12741# California Univ., Berkeley.
CRYOGENICS, SUPERCONDUCTING MAGNETS, AND FUSION POWER: A GLIMPSE INTO THE FUTURE
C. E. Taylor 29 Oct. 1971 24 p refs Presented at the Cryogenic Eng. Conf., Washington, D. C.
(UCRL-73187; Conf-710829-1) Avail: NTIS

The size, shape, and cost of several possible fusion-reactor coil systems are presented, along with refrigeration requirements. There is little question that these large magnet systems are technically feasible to construct. The economic possibility of using nonsuperconducting or partially superconducting hybrid conductors for large fusion systems is presented, and the possibility that there may not be enough helium available to refrigerate the coils in a hypothetical fusion-power economy eighty years from now is discussed briefly. Author (NSA)

N73-13864* Air Force Aero Propulsion Lab., Wright-Patterson AFB, Ohio.
POWER AND ENERGY FOR POSTERITY
Robert F. Barthelemy and Robert F. Cooper *In* NASA. Marshall Space Flight Center Space for Mankind's Benefit 1972 p 355-359
CSCL 10B

The proceedings of a space congress held at Huntsville, Alabama during November 1971 are presented. The theme of the conference was Space for Mankind's Benefit. The subjects discussed were: (1) man in near-earth space, (2) fundamental benefits of the space program, (3) benefits of orbital surveys and space technology to environmental protection, (4) benefits to telecommunications, navigation and information systems, (5) benefits to future power generations and energy production, and (6) general technology utilization in the public sector.

N73-13870* Little (Arthur D.), Inc., Cambridge, Mass. Engineering Sciences Section.
POWER WITHOUT POLLUTION
Peter E. Glaser *In* NASA. Marshall Space Flight Center Space for Mankind's Benefit 1972 p 431-439 refs

CSCL 10B

Details of several methods of converting solar energy to power without pollution are given. Data cover technical, economic, and social issues. E.H.W.

N73-15339*# Bendix Corp., Ann Arbor, Mich. Aerospace Systems Div.
ECOLOGICAL EFFECTS OF STRIP MINING IN OHIO Bimonthly Progress Report, 1 Nov. 1972 - 1 Jan. 1973
Phillip Chase, Principal Investigator 1 Jan. 1973 5 p
(Contract NAS5-21762)
(E73-10003; NASA-CR-129927; Rept-73-141-079) Avail: NTIS HC $3.00 CSCL 08I

The author has identified the following significant results. One result significant as a practical application and for cost benefit analysis is the relative ease with which ERTS-1 will monitor new and unclaimed stripping activities in Southeastern Ohio and in all of Appalachia. Band 5 resolution appears to be better than the often reported 80 meters. The strip mines stand out well enough to be easily identified without other graphic aids. Standing water within the strip mined area stands out in either bands 6 or 7. Areas of several acres are visible. Significant increases in surface extent of water of stripped areas should be detectable on a comparative basis. The degree of reclamation is

observable in the imagery in rather gross percentage steps and for areas larger than the bare earth sizes in the table. The gradation in tones in the different bands indicates that probability density imagery using the four bands in CCT data (and statistical processing) is likely to separate degrees of vegetative reclamation.

N73-15693*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EMERGING NEEDS FOR MOBILE NUCLEAR POWER-PLANTS
John L. Anderson 1972 39 p refs Presented at Winter Meeting of the Am. Nucl. Soc., Washington, 12-17 Nov. 1972
(NASA-TM-X-68164; E-7224) Avail: NTIS HC $4.00 CSCL 18E

Incentives for broadening the present role of civilian nuclear power to include mobile nuclear power plants that are compact, lightweight, and safe are examined. Specifically discussed is the growing importance of: (1) a new international cargo transportation capability, and (2) the capability for development of resources in previously remote regions of the earth including the oceans and the Arctic. This report surveys present and potential systems (vehicles, remote stations, and machines) that would both provide these capabilities and require enough power to justify using mobile nuclear reactor power plants. Author

N73-15699# European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center.
HYDROGEN AS AN ENERGY VECTOR: NEW FUTURE PROSPECTS FOR APPLICATIONS OF NUCLEAR ENERGY
G. Beghi May 1972 20 p refs
(EUR-4838) Avail: AEC Depository Libraries

In view of a wider penetration of nuclear energy in the energy field and therefore of a diversification of its applications, the usefulness of an intermediary energy vector is pointed out. Therefore hydrogen is examined as to its present potential uses in the future. Among the hydrogen production processes, the method of dissociation of water with a closed cycle of chemical reactions and utilizing nuclear heat seems particularly promising. Author (NSA)

N73-16766# California Univ., Livermore. Lawrence Livermore Lab.
SURVEY OF HYDROGEN'S POTENTIAL AS A VEHICULAR FUEL
A. L. Austin 19 Jun. 1972 35 p refs
(Contract W-7405-Eng-48)
(UCRL-51228) Avail: NTIS

The problems and potential of various hydrogen-based mobile fuel systems and the likely economic impact of a nationwide conversion to hydrogen are examined. The basic technical problem is to store enough hydrogen per vehicle in a small enough volume. The prospects of using gaseous and liquid hydrogen with air, liquid hydrogen with liquid oxygen, and hydrogen stored in metal hydrides in an internal combustion engine are analyzed. The practical feasibility is found to be marginal but with enough potential to justify an ongoing research program. Author

N73-17989# Committee on Science and Astronautics (U. S. House).
ENERGY RESEARCH AND DEVELOPMENT
Washington GPO 1972 730 p refs Hearings before Comm. on Sci. and Astronaut., 92d Congr., 2d Sess., no. 24, 9-11, 23-25, and 30 May 1970
Avail: Subcomm. on Sci., Res. and Develop.

The hearings concerning the Nation's critical energy needs are reported. The energy research and development which are discussed in terms of providing clean energy in quantities to meet the increasing demands. Topics discussed include: nuclear options, fossil fuel options, allocation of prime sources, solar radiation, energy consumption, fuel economy/efficiency, and coal gasification. F.O.S.

N73-18093# Army Foreign Science and Technology Center, Charlottesville, Va.
AUTONOMOUS ENERGETICS: ENERGY SOURCES FOR THE EARTH, SEA AND SPACE
26 Jun. 1972 5 p Transl. into ENGLISH from Khim. Zhizn (USSR), no. 10, 1970 p 34-36
(AD-753828; FSTC-HT-23-1088-72) Avail: NTIS CSCL 10/2

In February 1970, a general meeting of the Academy of Sciences of the USSR was held, devoted to the role of science in technical progress. In speaking of principal trends of development in modern science, the president of the Academy of Sciences, academician M. V. Keldysh mentioned the importance of work in the field of autonomous energetics. A member of the Academy of Sciences of the USSR, N. S. Lidorenko, told about the work that is going on in the development of physical and chemical energy sources. Author (GRA)

N73-20820# Mitre Corp., McLean, Va.
ENERGY, RESOURCES AND THE ENVIRONMENT
Charles A. Zraket 24 Oct. 1972 40 p refs Revised
(PB-213031; MITRE-72-180-Rev-2) Avail: NTIS HC $3.75 CSCL 21D

A substantive summary of the eight symposia sponsored by MITRE on the interrelationships of energy, resources and the environment during the period July 1971 to July 1972 is presented. Author (GRA)

N73-20976# Committee on Commerce (U. S. Senate).
ENERGY RESEARCH AND DEVELOPMENT
Washington GPO 1972 380 p refs Hearings on Amendment 364 to S. 1684 before Comm. on Com., 92d Congr., 2d Sess., 15-16 Mar. 1972
Avail: Comm. on Com.

Senate hearings on the research and development of electric power production and related industries are reported. The objectives are to survey the need for and to appraise the workability of a Federal power research and development program and to assist private industry in ecologically constructive efforts to guarantee the present and future power needs of the U.S. J.M.M.

N73-20991# Mitre Corp., McLean, Va. Transportation Systems Engineering Dept.
US TRANSPORATION: SOME ENERGY AND ENVIRONMENTAL CONSIDERATIONS
W. E. Fraize Sep. 1972 50 p refs
(PB-213034; MITRE-72-164) Avail: NTIS HC $3.75 CSCL 13B

The role of transportation in air pollution and consumption of energy, especially petroleum, is reviewed, with emphasis on the U.S. situation. Both technological and control measures for each problem area are discussed. Technological measures focus on the automobile, high speed ground transportation modes, and non-petroleum fuels, while control measures, which encourage the use of the more efficient transportation modes, are seen to offer significant benefits. The near future is discussed with respect to the impact of the U.S. Amended Clean Air Act of 1970. Transportation evolution over the next few decades is projected. Author (GRA)

N73-22711*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
PRELIMINARY APPRAISAL OF HYDROGEN AND METHANE FUEL IN A MACH 2.7 SUPERSONIC TRANSPORT
John B. Whitlow, Jr., Richard J. Weber, and Kestutis C. Civinskas [1972] 51 p refs Prepared in cooperation with Army Air Mobility R and D Lab. Cleveland
(NASA-TM-X-68222; E-7425) Avail: NTIS HC $4.75 CSCL 21D

The higher heating value of hydrogen relative to JP fuel is estimated to reduce fuel weight by three fold and gross weight by 40 percent for comparable designed airplanes of equal payload and range. Engine design parameters were varied to determine

the influence of lower noise goals on gross weight and direct operating cost. At current fuel prices, the DOC of a hydrogen airplane would be much higher than that of a JP airplane. A methane airplane could offer an 8.5-percent lower KOC than JP. But future shortages may escalate the prices of both JP and methane, whereas the price of hydrogen manufactured hydrolytically could be reduced from present levels. If in the future all three fuels are postulated to have equal costs per unit of energy, the DOC for hydrogen could be as much as 20 percent below that for JP on the reference 4000-nautical-mile mission. Longer ranges or lower noise requirements would improve the advantage of hydrogen. Author

N73-22928# Committee on Science and Astronautics (U. S. House).
THE FEDERAL GOVERNMENT AND ENERGY RESEARCH AND DEVELOPMENT HISTORICAL BACKGROUND
Washington GPO Mar. 1973 111 p refs Presented by Subcomm. on Energy to the Comm. on Sci. and Astronaut., 93d Congr., 1st Sess., 20 Mar. 1973 Prepared by Library of Congr.
Avail: US Capitol, House Document Room

A congressional study is reported on the history of American energy production methods and techniques aimed at a comprehensive national energy research and development policy. Pertinent testimony was obtained from such authorities as the Department of the Interior, the National Bureau of Standards, the Federal Power Commission, the Tennessee Valley Authority, NASA, and sources from private industry. Results of the study revealed the need for a unified national policy directly sensitive to increased present and future power requirements. J.M.M.

N73-23962# RAND Corp., Santa Monica, Calif.
GROWTH RATES WITHIN THE TRANSPORTATION SECTOR
W. E. Mooz Jan. 1973 10 p Presented at Sem. on Energy as a Scarce Resource, Pasadena, Calif., 9 Dec. 1972; sponsored by Environ. Qual. Lab., the Sierra Club, and League of Women Voters
(P-4935) Avail: NTIS HC $3.00

Report is made of an investigation into the nature of transportation in terms of energy depletion and fuel consumption. Graphic profiles are presented which trace the growth rates of specific modes of passenger and freight transportation from 1955 to 1968. A summary of likely transportation energy demands for the future is also included. J.M.M.

N73-23969# Committee on Science and Astronautics (U. S. House).
BRIEFINGS BEFORE THE TASK FORCE ON ENERGY, VOLUME 3
Washington GPO 1972 203 p refs Presented to Comm. on Sci. and Astronaut., 92d Congr., 2d Sess., 15 Aug. 1972
Avail: Subcomm. on Sci., Res., and Develop.

The hearings concerning the energy problems of the U.S. are reported. Topics discussed include: environmental protection, better use of natural resources, R and D priorities, water and air pollution, electric power generation, and economic growth. F.O.S.

N73-24777*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
THE USE OF HYDROGEN FOR AIRCRAFT PROPULSION IN VIEW OF THE FUEL CRISIS
Solomon Weiss 1973 38 p refs Presented at NASA Res. and Technol. Advisory Comm. on Aeronaut. Operating Systems, Moffett Field, Calif., 7-8 Mar. 1973
(NASA-TM-X-68242; E-7490) Avail: NTIS HC $4.00 CSCL 21D

Some factors influencing the technical feasibility of operating a liquid hydrogen-fueled airplane are discussed in light of the projected decrease of fossil fuels. Other sources of energy, such as wind, tidal, solar, and geothermal, are briefly mentioned. In view of projected decreases in available petroleum fuels, interest has been generated in exploiting the potential of liquid hydrogen (LH2) as an aircraft fuel. Cost studies of LH2 production show it to be more expensive than presently used fuels. Regardless of cost considerations, LH2 is viewed as an attractive aircraft fuel because of the potential performance benefits it offers. Accompanying these benefits, however, are many new problems associated with aircraft design and operations; for example, problems related to fuel system design and the handling of LH2 during ground servicing. Some of the factors influencing LH2 fuel tank design, pumping, heat exchange, and flow regulation are discussed. Author

N73-29368# Interior Dept., Washington, D.C.
ENVIRONMENTAL STATEMENT FOR THE PROPOSED PROTOTYPE OIL-SHALE LEASING PROGRAM. VOLUME 2: ENERGY ALTERNATIVES
Sep. 1972 228 p refs
(EIS-AA-72-5242-D-2-Vol-2) Avail: NTIS HC $13.50

This section of the environmental impact statement discusses energy alternatives to the proposed action cast in the framework of the Proposed Prototype Oil-Shale Leasing Program. This prototype plan anticipates six test leases, two each in the States of Colorado, Utah, and Wyoming, and a program that might lead to a maximum total production of 1 million barrels of shale oil per day by the year 1985 from both public and private lands. This document discusses: (1) energy situation; (2) role of energy in economic growth; (3) energy requirements of the U.S. to meet projected future needs; (4) substitutability of energy forms; (5) factors that affect fuels development; (6) background of petroleum situation, both present and future; (7) oil-shale development possibilities; and (8) alternatives to the Proposed Prototype Oil-Shale Leasing Program. Author

N73-30975# Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland).
BIBLIOGRAPHIC COMPILATION AND TABULATION OF RESOURCES, OF THEIR CONSUMPTION AND THEIR WASTE IN THE WORLD [COMPILATION BIBLIOGRAPHIQUE ET TABULATION DES RESSOURCES, DE LA CONSOMMATION ET DES DECHETS DANS LE MONDE]
M. Roux Jul. 1973 66 p refs In FRENCH; ENGLISH summary
(LRP-63/73) Avail: NTIS HC $5.50

The available resources of fossil and nuclear fuels as well as those of solar energy, hydroelectric power and others are reviewed and compared to the global consumption of energy in the world, the USA, the Common Market and Switzerland. The per capita and global comsumption together with its growthrate, are presented and distributed with respect to primary energy sources and/or main sectors of use. Attention is focused on the energy required by the generatation of electrical power. Estimates up to the year 2000 are also given. Due to a twofold increase both in the world population and in the per capita consumption, the energy demand by the year 2000 will be four times higher than its present level. Wastes from the nuclear economy are estimated up to the year 2000. The relative biological hazards pertaining to the radioactive inventories and wastes of fission reactors are compared to those of a reference fusion reactor. Author

N73-31867*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
SIGNIFICANT ACCOMPLISHMENTS IN SCIENCES: GODDARD SPACE FLIGHT CENTER, 1972
Washington 1973 223 p Proc. of a Symp., Greenbelt, Md., 7-8 Nov. 1972
(NASA-SP-331) Avail: NTIS HC $5.50 CSCL 05B

Space applications research is reported in the following areas: High energy and solar astronomy; optical and UV astronomy; Planetary, lunar, and cometary studies; earth observations; and earth physics.

N73-31900* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
EARTH OBSERVATIONS, OVERVIEW
William Nordberg *In its* Significant Accomplishments in Sci. 1973 p 161-177
CSCL 08E

An overview is given of research and development activities at the Laboratory for Meteorology and Earth Sciences. Highlights of satellite techniques in earth observation missions and projects are outlined, as are remote sensing methods by aircraft overflights; most noteworthy among these is the development of multispectral scanners that monitor both the reflected infrared solar radiation and the emitted terrestrial radiation. The application of observations to the survey of environmental conditions and resource management is emphasized. G.G.

N73-33005# California Univ., Livermore. Lawrence Livermore Lab.
DEVELOPMENT OF MATERIALS FOR ENERGY RELATED APPLICATIONS
J. S. Kane 10 Apr. 1973 16 p refs Presented at 2d Cairo Solid State Conf., Cairo, 21-26 Apr. 1973 Sponsored by AEC
(UCRL-74697; Conf-730416-2) Avail. NTIS HC $3.00

The application of materials science and technology to develop new energy sources and to make current energy systems more efficient is discussed. The energy sources discussed include solar energy, thermonuclear energy, and fossil fuel energy. Energy conversion techniques discussed include thermal cycles, solar photovoltaic, thermal decomposition of water, and hydrogen-air fuel cells. The methods for energy transmission that are outlined are hydrogen pipelines and superconducting or cyrogenic electrical transmission lines. Transportation optimization and efficiency are dealt with in the light of those components yielding the largest benefit for the overall system. NSA

N73-33928# Committee on Science and Astronautics (U. S. House).
SHORT TERM ENERGY SHORTAGES
Washington GPO 1973 928 p refs Hearings before Comm. on Sci. and Astron., 93d Cong., 1st Sess., No. 7, 3, 8 and 17 May 1973
Avail: Subcomm. on Energy

Congressional hearings are given on the causes and implications of impending shortages of gasoline, heating oil, diesel fuel, jet engine fuel, and electricity. The immediate energy shortages and policy options are discussed in three parts: (1) the character of the present energy crisis, (2) the relationship of energy growth and economic growth, and (3) the relationship of short-run measures and long-term objectives. Short term fuel shortages are given along with their effects on the electric utilities. The hearings take into account the regulated energy industries and the effect of the present situation on energy research and development. A gas field identification list is included. T.M.R.

02 SOLAR ENERGY

Includes solar collectors and solar cells; efforts to achieve practical and economical use of solar energy for heating and cooling of buildings, heating or water, generation of electricity, and production of clean fuel.

A68-12549

DETERMINATION OF THE OPTIMAL DIMENSIONS OF HIGH-TEMPERATURE CYLINDRICAL-CAVITY SOLAR ENERGY RECEIVERS.

I. M. Rubanovich (Vsesoiuznyi Nauchno-Issledovatel'skii Institut Istochnikov Toka, Kishinev, Moldavian SSR).

(Geliotekhnika, vol. 1, July-Aug. 1965, p. 11-22.)

Applied Solar Energy, vol. 1, July-Aug. 1965, p. 9-20. 18 refs. Translation.

Examination of the operation of the concentrator and receiver of a high-temperature cylindrical-cavity solar energy receiver for determining the optimal dimensions of such a receiver. The concentrator studied was of the paraboloidal mirror type. As part of the optimization process, receiver losses associated with the escape of radiant energy from the receiver inlet and the mean coefficient of irradiation of the cavity inlet from its inner surface had to be determined. Several means for increasing the efficiency of receivers are presented. R. B. S.

A68-15419 #

TECHNOLOGY AND ELECTRICAL CHARACTERISTICS OF GALLIUM ARSENIDE SOLAR CELLS [TECNOLOGIA E CARATTERISTICHE ELETTRICHE DI CELLE SOLARI AD ARSENIURO DI GALLIO].

F. P. Califano (Napoli, Università, Istituto di Elettrotecnica, Naples, Italy) and P. Spirito.

Rivista di Ingegneria, Nov. 1967, p. 924-929. 12 refs. In Italian. Research supported by the Consiglio Nazionale delle Ricerche.

Description of the technological processes used in the construction of type III-V GaAs solar cells with an actual conversion efficiency of approximately 10%. The properties of gallium arsenide are briefly reviewed, and the characteristics of the components constructed with it are described. M. M.

A68-15882

KAUFMAN POWER PLANTS WITH SOLAR CELLS - ENERGY-SUPPLY DEVICES FOR MISSIONS IN THE NEAR FUTURE [KAUFMAN-TRIEBWERKE MIT SOLARZELLEN-ENERGIEVERSORGUNGSANLAGEN FÜR ZUKUNFTSNAHE MISSIONEN].

G. F. Au.

Luftfahrttechnik Raumfahrttechnik, vol. 13, Dec. 1967, p. 305-310. 29 refs. In German.

Description of the Kaufman electrical generator to be used in conjunction with solar cells for the production of power in the 2 to 4-kw range. The SERT II mission - an earth-orbiting mission scheduled for 1969 - will be characterized by the use of the Kaufman generator. The mercury fuel system, discharge chamber, acceleration system, and plasma-bridge neutralizing cathode are examined. R. B. S.

A68-16784 *

CONFIGURATION SELECTION AND PERTURBATION EFFECTS FOR A LARGE ORBITING SOLAR ARRAY.

J. Rebman (Radio Corporation of America, Defense Electronic Products, Astro-Electronics Div., Princeton, N.J.).

IN: SATURN V/APOLLO AND BEYOND; NATIONAL SYMPOSIUM, HUNTSVILLE, ALA., JUNE 11-14, 1967, TRANSACTIONS. VOLUME 2.

Symposium sponsored by the American Astronautical Society, the University of Alabama, NASA, and the U.S. Army.

Edited by S. S. Hu.

Tarzana, Calif., American Astronautical Society, 1967. 17 p. Contract No. NAS 9-5266.

Discussion of the development of an optimum array-spacecraft configuration, representing one of the prime problems encountered in the design of a large orbiting solar array. After establishing the mission parameters (power requirements, orbit parameters, booster selection, and spacecraft orientation requirements), various array configurations are analyzed with respect to packaging constraints, mechanical integrity, and orbiting perturbation effects. One or more array configurations are then selected based on fuel consumption resulting from perturbation effects, array shadowing, array dynamical behavior, and possible constraints on the mission due to the configuration. A large number of configurations were considered with two basic types selected for further detailed analysis. Of these, one was selected to minimize orbital fuel consumption, place minimum constraints on mission goals, and perform satisfactorily at the required altitudes. P. v. T.

A68-17380 *

A SOLAR ARRAY OPTIMAL POWER CONVERSION TECHNIQUE.

Robert Rosen (Hughes Aircraft Co., Aerospace Group, Culver City, Calif.).

(Institute of Electrical and Electronics Engineers, Aerospace and Electronic Systems Technical Convention, Washington, D.C., Oct. 16-18, 1967, Paper.)

IEEE Transactions on Aerospace and Electronic Systems, Supplement, vol. AES-3, Nov. 1967, p. 504-510.

Contracts No. NAS 5-9210; No. NAS 5-10225.

Description of a technique for efficiently coupling the maximum power available from a solar array to a spacecraft battery. Conversion of power was accomplished by using high-efficiency switching techniques. The power was coupled through a transformer which had a known primary inductance. Optimum power convergence was afforded over a wide range of input and output conditions, due to the flexibility provided by this technique. The derivation of the design equations and their subsequent verification by the design and construction of two working units are described. The two cases considered were felt to be representative of many conceivable system configurations. Incorporation of this technique into the power-system design for many types of spacecraft could result in an overall reduction in size and weight for the vehicle. The high efficiency of the power-coupling circuits may also increase the probability of mission success, because of the low component stresses in these areas. F. R. L.

A68-18449 #

OPTICAL CHARACTERISTICS OF SILICON PHOTOCELLS AND THE EFFICIENCY OF A THERMAL PHOTOELECTRIC CONVERTER [OPTICHESKIE KHARAKTERISTIKI KREMNIEVYKH FOTOELEMENTOV I K.P.D. TERMOFOTOELEKTRICHESKOGO PREOBRAZOVATELIA].

A. M. Vasil'ev, T. M. Golovner, A. P. Landsman, and N. S. Lidorenko.

Teplofizika Vysokikh Temperatur, vol. 5, Nov.-Dec. 1967, p. 1079-1086. 8 refs. In Russian.

Experimental investigation of the optical characteristics of conventional silicon photocells of the type employed in thermophotoelectric converters. The efficiency of such converters is studied as a function of the optical characteristics. It is shown that an efficiency of roughly 10% can be expected from modern silicon photocells using an emitter with a temperature of 1900°C. Given particularly favorable optical characteristics, the efficiency can be as high as 25%. V. P.

A68-20595

AIR FORCE ADVANCED SOLAR TURBO ELECTRIC CONCEPT.

Jerome Werbel and Charles L. Midyett (USAF, Systems Command, Research and Technology Div., Aerospace Propulsion Laboratory, Wright-Patterson AFB, Ohio).

(USAF, Office of Scientific Research and United Aircraft Corp., Symposium on Advanced Propulsion Concepts, 4th, Palo Alto, Calif., Apr. 26-28, 1965, Paper.)

IN: ADVANCED PROPULSION CONCEPTS; PROCEEDINGS OF THE FOURTH SYMPOSIUM, PALO ALTO, CALIF., APRIL 26-28, 1965.

Symposium sponsored by the Office of Scientific Research of the U.S. Air Force and the United Aircraft Corp.

New York, Gordon and Breach, Science Publishers, Inc., 1966, p. 207-222; Discussion, p. 223, 224. 11 refs.

Discussion of the Advanced Solar Turbo Electric Concept (ASTEC) for satisfying the growing needs for space vehicle power requirements. Conversion of solar energy to usable electrical output by a solar dynamic energy-conversion system aboard a space vehicle requires a collector, heat receiver, energy-conversion devices, and radiator. The collector concentrates the solar flux into a heat receiver unit. In the heat receiver, the heat transmitted by the collector is transferred to the working fluid, raising its energy level. The working fluid is then admitted to the first energy-conversion device (turbine), where the heat energy is converted to kinetic energy in the form of shaft power. This power drives the second energy-conversion device (alternator), which produces a useful electric output. Meanwhile, the working fluid enters the radiator where it gives up its excess energy to space. From the radiator the working fluid is then pumped back into the heat receiver for the beginning of another Rankine cycle. S.H.B.

A68-20738

RECENT PROGRESS OF THIN FILM SOLAR CELLS.
David M. Perkins (Northern College of Applied Arts and Technology, Ontario, Canada).
Advanced Energy Conversion, vol. 7, Feb. 1968, p. 265-274.
20 refs.

Detailed discussion of the material used in the production of thin-film solar cells, such as CdS, CdTe, and GaAs. The fabrication, structure, and properties of these cells are described and related to their solar conversion efficiency, specific power-to-weight ratio, and environmental stability. In addition, the characteristics of these thin-film cells are discussed with respect to practical space applications. R.B.S.

A68-22516 *

SOLAR COLLECTION LIMITATIONS FOR DYNAMIC CONVERTERS.
George L. Schrenk (Pennsylvania, University, Philadelphia, Pa.).
IN: COMBUSTION AND PROPULSION; AGARD COLLOQUIUM ON ENERGY SOURCES AND ENERGY CONVERSION, 6TH, CANNES, FRANCE, MARCH 16-20, 1964, PAPERS.
Research sponsored by the Combustion and Propulsion Panel of NATO-AGARD.
Edited by H. M. DeGroff, R. F. Hoglund, J. Fabri, T. F. Nagey, and R. E. Rumbaugh, Jr.
New York, Gordon and Breach, Science Publishers, Inc. (AGARDograph 81), 1967, p. 25-44; Discussion, Touchais, p. 45, 46.
23 refs. Discussion in French.
Research supported by the General Motors Corp.; Grant No. NsG-316.

Analysis of actual solar collectors on the basis of a mathematical model which makes it possible to calculate the energy flux on any arbitrarily shaped focal surface from any arbitrarily shaped collector surface without making numerical approximations. This model has recently been used to investigate the interface between the collector and the heat receiver (the cavity opening). The directional assumption often made for this interface is that this opening can be treated as if it were a plane surface emitting radiation according to Lambert's law (the cosine law). Results are given which clearly show that this assumption is in substantial error for both perfect and imperfect collectors. Cylindrical heat receivers coupled with typical reflectors are analyzed in detail, using an open-cavity Fredholm integral equation approach and the valid directional distribution. The effects of the absorptivity and emissivity of the walls of the heat receiver are investigated, and the reradiation losses and system performance are calculated. T.M.

A68-22525

LIMITATIONS OF SOLAR COLLECTORS FOR CONVERTERS [LIMITATIONS DES COLLECTEURS SOLAIRES POUR CONVERTISSEURS].
F. Trombe (Centre National de la Recherche Scientifique, Laboratoire de l'Energie Solaire, Mont-Louis, Pyrénées-Orientales, France) and E. Le Grives (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France).
IN: COMBUSTION AND PROPULSION; AGARD COLLOQUIUM ON ENERGY SOURCES AND ENERGY CONVERSION, 6TH, CANNES, FRANCE, MARCH 16-20, 1964, PAPERS.
Research sponsored by the Combustion and Propulsion Panel of NATO-AGARD.
Edited by H. M. DeGroff, R. F. Hoglund, J. Fabri, T. F. Nagey, and R. E. Rumbaugh, Jr.
New York, Gordon and Breach, Science Publishers, Inc. (AGARDograph 81), 1967, p. 279-312; Discussion, G. L. Schrenk (Pennsylvania, University, Philadelphia, Pa.) and Touchais, p. 312-314.
22 refs. In French; Discussion in English and French.

Account of research on solar-energy collectors and receivers for space applications. Various concentrator concepts are reviewed, and receiver configurations leading to the most promising performances are defined. The main factors affecting collector efficiency (geometrical perfection, optical qualities, structural rigidity, and response to meteorite impacts) and receiver efficiency (absorption characteristics and surface radiation) are analyzed. M.F.

A68-31623

INVESTIGATIONS ON SILICON P-N JUNCTION FOR SOLAR ENERGY CONVERSION.
R. B. Gangadhar, R. S. Mathur, H. K. Sehgal, and Arun P. Kulshreshtha (Indian Institute of Technology, Dept. of Physics, New Delhi, India).
(Council of Scientific and Industrial Research, Convention, Banaras Hindu University, Varanasi, India, Mar. 1967.)
Indian Journal of Pure and Applied Physics, vol. 5, Dec. 1967, p. 593-595. 5 refs.
Research supported by the Council of Scientific and Industrial Research.

Phosphorus and boron diffused solar cells have been fabricated. A simple technique is developed for providing ohmic meshed contacts for samples. Study of various characteristics has shown the superiority of boron diffused solar cells over phosphorus diffused ones. (Author)

A68-33039 #

SOLAR CELLS FOR ONBOARD ENERGY SUPPLY IN SPACE VEHICLES [SOLARZELLEN ZUR BORDENERGIEVERSORGUNG VON RAUMFLUGKÖRPERN].
E. Hollax.
Astronomie und Raumfahrt, no. 1, 1968, p. 6-10. 6 refs. In German.

Brief examination of the characteristics of and advantages offered by the solar cell as a means of energy supply in spacecraft. The design, operation, and power output of various cells are discussed, and the critical particle bombardment for different types of cells is outlined. It is seen that for short operational times the p/n silicon cell is to be preferred, while for long periods of time the n/p silicon cell is better adapted. R.B.S.

A68-34613 #

THE CdS THIN FILM SOLAR CELL.
F. A. Shirland (Clevite Corp., Electronic Research Div., Solar Battery Section, Cleveland, Ohio).
IN: SEMICONDUCTOR COMPONENTS AND INTEGRATED CIRCUITS; VERBAND DEUTSCHER ELEKTRONIKER, CONFERENCE OF ELECTRONIC SPECIALISTS, HANOVER, WEST GERMANY, MAY 2, 3, 1968, PROCEEDINGS [HALBLEITER-BAUELEMENTE UND INTEGRIERTE SCHALTUNGEN; VERBAND DEUTSCHER ELEKTRONIKER, FACHTAGUNG ELEKTRONIK, HANOVER, WEST GERMANY, MAY 2, 3, 1968, PROCEEDINGS].
Hanover, West Germany, Deutsche Messe- und Ausstellung AG, 1968, p. 14-21. 6 refs. In German.

Description of a CdS thin-film solar cell designed as a more advanced alternative to the conventional silicon photovoltaic cell for converting light into electric energy. The advantages of the new cell are a simpler polycrystal deposition process, cell activation by a simple chemical conversion of the CdS surface into Cu_2S, high flexibility and ruggedness of the device, and feasibility of low-cost mass fabrication. It is indicated that the favorable results obtained on recent meteorological balloon flights have increased the demand for the new solar cell. V.Z.

A68-38889 *
TECHNOLOGY OF LARGE (1 KW TO 5 KW) SOLAR ARRAYS.
Karl Martinez and Edgar W. Miles (Boeing Co., Aerospace Group, Space Div., Seattle, Wash.).
(Deutsche Gesellschaft für Raketentechnik und Raumfahrt, Symposion über Energieversorgung im Weltraum II, Munich, West Germany, Mar. 14, 1968.)
Raumfahrtforschung, vol. 12, July-Sept. 1968, p. 138-142.
NASA-sponsored research.
Description of the manufacture of rigid modular deployable solar arrays. Areas covered include cell types, cell thickness, packaging and connection of cells, structures for the rigid deployable array, the assembly of the array, and solar cells grouping. Future trends in the technology of solar cells are briefly considered.
R.B.S.

A68-39356
OPTICAL CHARACTERISTICS OF SILICON PHOTOCELLS AND THE EFFICIENCY OF A THERMOPHOTOELECTRIC CONVERTER.
A. M. Vasil'ev, T. M. Golovner, A. P. Landsman, and N. S. Lidorenko.
(Teplofizika Vysokikh Temperatur, vol. 5, Nov.-Dec. 1967, p. 1079-1086.)
High Temperature, vol. 5, Nov.-Dec. 1967, p. 967-973. 8 refs.
Translation.
Experimental investigation of the optical characteristics of conventional silicon photocells of the type employed in thermophotoelectric converters. The efficiency of such converters is studied as a function of the optical characteristics. It is shown that an efficiency of roughly 10% can be expected from modern silicon photocells using an emitter with a temperature of 1900°C. Given particularly favorable optical characteristics, the efficiency can be as high as 25%. V.P.

A68-40644
PHYSICAL PROBLEMS CONNECTED WITH THE STUDY OF ELECTROMAGNETIC ENERGY, PARTICULARLY OF THE SUN [PROBLEMI FISICI CONNESSI CON LO STUDIO DELL'ENERGIA ELETTROMAGNETICA, IN PARTICOLARE DEL SOLE].
Franco Valli.
Rivista Aeronautica, Supplemento Tecnico, 1968, p. 153-182.
In Italian.
Discussion of physical phenomena and problems connected with the study of electromagnetic energy. The possibility of transforming solar energy into electric power is examined, and the trends of current investigations of the uses and methods of conversion of solar energy are briefly reviewed.
M.M.

A68-41092 #
EXPERIMENTAL MEASUREMENTS OF CONCENTRATED SOLAR ENERGY PATTERN IN FOCUS OF A PLANE SEGMENTS CONCENTRATOR.
I. A. Sakr and N. H. Helwa.
Coopération Méditerranéenne pour l'Energie Solaire, Bulletin no. 14, July 1968, p. 27-35. 6 refs.
Determination of the pattern of radiant energy distribution and temperature for a parabolic-cylinder concentrator constructed from plane mirror segments. The ratio of the coefficient of the radiation concentration at the focus to the aperture of the concentrator is determined. A steady-state heat-balance equation is presented for the concentrator. The characteristics of the focal plane of the concentrator are studied.
M.G.

A68-41941
SOLAR CELLS AND SOLAR-CELL GENERATORS FOR SPACE TRAVEL [SOLARZELLEN UND SOLARZELLENGENERATOREN FÜR DIE RAUMFAHRT].
Siegfried Karius.
Technische Mitteilungen AEG-Telefunken, vol. 58, no. 2, 1968, p. p. 71-73. In German.
Assessment of solar cells, which convert light directly into energy, and are used as a power supply for spacecraft. After a short discussion of their potential, the properties of solar cells and the influence of particle radiation and temperature on the characteristics of these cells are described. The structure of generators consisting of solar cells is sketched, and a summary of the R&D plans of the AEG-Telefunken of Germany in the fields of solar cells and solar-cell generators is given.
P.v.T.

A68-42518 *
STATUS OF THE CADMIUM SULFIDE THIN-FILM SOLAR CELL.
F. A. Shirland (Clevite Corp., Cleveland, Ohio), A. F. Forestieri, and A. E. Spakowski (NASA, Lewis Research Center, Cleveland, Ohio).
IN: IECEC '68; INTERSOCIETY ENERGY CONVERSION ENGINEERING CONFERENCE, UNIVERSITY OF COLORADO, BOULDER, COLO., AUGUST 13-17, 1968, RECORD. VOLUME 1.

New York, Institute of Electrical and Electronics Engineers, Inc. (IEEE Publication 68 C 21-Energy), 1968, p. 112-115. 7 refs.
A brief description is given of the design of the cadmium sulfide thin-film solar cell as it has evolved to date for space applications. The performance levels achieved are summarized along with the degree of reproducibility and yields obtained on pilot production in recent months. Improvements in design and performance presently being investigated are also discussed. A summary of the results of testing of cadmium sulfide thin-film solar cells is presented. These include cells subjected to the following conditions: wet shelf storage, dry shelf storage, vacuum thermal storage, and vacuum thermal cycling.
(Author)

A68-42560 *
A DESIGN CONCEPT FOR A 30 WATTS PER POUND ROLLUP SOLAR ARRAY.
N. F. Shepard, Jr. and K. L. Hanson (General Electric Co., Philadelphia, Pa.).
IN: IECEC '68; INTERSOCIETY ENERGY CONVERSION ENGINEERING CONFERENCE, UNIVERSITY OF COLORADO, BOULDER, COLO., AUGUST 13-17, 1968, RECORD. VOLUME 1.

New York, Institute of Electrical and Electronics Engineers, Inc. (IEEE Publication 68 C 21-Energy), 1968, p. 549-559.
Contract No. JPL-951970.
A design concept for a 250-ft^2 rollup solar array system which has a power-to-weight ratio in excess of 30 W/lb is described. The tradeoff studies and analyses which led to the selection of a single deployable boom configuration are discussed. The structural stability of the deployed array is obtained by tension applied to the array substrate. An analytical model of the deployed array is formulated to determine the substrate preload required to obtain a specified first-mode natural frequency of greater than 0.04 Hz. The design of each major component is described.
(Author)

A68-43817
THE INFLUENCE OF COLLECTOR TEMPERATURE ON THE MAXIMUM EFFICIENCY OF A THERMIONIC CONVERTER IN THE SERIES BATTERY.
Krzysztof Urbaniec and Maciej Zgorzelski (Warszawa, Politechnika, Instytut Techniki Cieplnej, Warsaw, Poland).
Energy Conversion, vol. 8, Sept. 1968, p. 103-110. 11 refs.
Analysis of the influence of the collector temperature on the maximum obtainable efficiency of an ideal thermionic converter. It is shown that the maximum obtainable efficiency of an ideal thermionic converter (i.e., the efficiency calculated with all heat losses from the emitter taken into account, but without any plasma losses) may be higher in a converter operating at high collector temperatures than in the negligible collector emission case. It is also proved that above certain temperatures of the collector, low work function of its surface does not represent any advantages in respect to converter efficiency and that for a given value of collector work function and emitter temperature, there exists always an optimum collector temperature which maximizes the efficiency. For a collector work function of 1.8 eV, optimum collector temperature is about 900°C when emitter temperatures are high.
Z.W.

A69-12296
POWER FROM THE SUN - ITS FUTURE.
Peter E. Glaser (Arthur D. Little, Inc., Engineering Sciences Section, Cambridge, Mass.).
(Intersociety Energy Conversion Engineering Conference, Boulder, Colo., Aug. 13, 1968.)
Science, vol. 162, Nov. 22, 1968, p. 857-861. 16 refs.
Discussion of solar energy as the major future fuel resource, and evaluation of means for harnessing it to produce power on earth. The estimated surface area and estimated weight of satellite solar collectors for different photovoltaic energy-conversion devices of different efficiency, exclusive of the weight of structural components, are shown. It is pointed out that, although the use of satellites for conversion of solar energy may be several decades away, it is possible to explore several aspects of the required technology as a guide to future developments. M.M.

A69-15675 *
DESIGN AND PERFORMANCE ANALYSIS OF PANEL-TYPE SOLAR THERMOELECTRIC GENERATORS.
V. Raag (Radio Corporation of America, RCA Electronic Components and Devices Div., Harrison, N.J.).
Energy Conversion, vol. 8, Dec. 1968, p. 169-176. 9 refs.
Contract No. NAS 3-10600.
Derivation of performance equations for a panel-type solar thermoelectric generator, basing all calculations on a single thermocouple as the fundamental unit of the generator. Results show that the performance of the thermocouple is determined by initially assuming arbitrary dimensions for the various components. In a practical power generator, however, it is important that this performance be optimized with respect to some parameter, such as specific power (W/lb), or efficiency, which is directly related to the economics of producing the electrical power for space applications. This optimization should be made through a variation of parameters. Each parameter can be varied independently by fixing the values of the remaining parameters, thus achieving optimization for all parameters. This process is conveniently accomplished with a computer program. B.H.

A69-21823 *
ELECTRICAL TESTING OF A SIX-CONVERTER GENERATOR.
G. Stapfer and K. Shimada (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.).
IN: INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, ANNUAL THERMIONIC CONVERSION SPECIALIST CONFERENCE, 7TH, FRAMINGHAM, MASS., OCTOBER 21-23, 1968, CONFERENCE RECORD.
New York, Institute of Electrical and Electronics Engineers, Inc., 1968, p. 159-163.
Electrical testing of a solar energy thermionic generator (JG-4) was performed as a part of generator evaluation that includes the solar testing. The generator consists of six individual converters (SET-type) mounted radially on a cylindrical cavity to receive equal amounts of incoming thermal flux. The maximum output power was 140 W at an output voltage of 3.0 V, with an overall efficiency of approximately 4.5%. These results were obtained at an emitter temperature of 1700°C, which was lower than desired, and at collector temperatures higher than expected. During the electrical testing of the JG-4, anomalies were noted, namely: (1) overheating of collectors and metal-ceramic seals, and (2) a dual-current mode of generator operation. The first occurred because the available surface area, as dictated by a geometrical constraint of the generator configuration, was inadequate for radiative heat dissipation. The second anomaly was caused by the simultaneous occurrence of an ignited mode and an unignited mode in the six series-connected converters. (Author)

A69-22534
COMPUTATION AND OPTIMIZATION OF THE THERMAL REGIME IN CONCENTRATOR-TYPE SOLAR DEVICES.
R. A. Zakhidov and D. I. Tepliakov (Akademiia Nauk SSSR, Energeticheskii Institut, Moscow, USSR).
(Geliotekhnika, vol. 2, no. 2, 1966, p. 12-19.)
Applied Solar Energy, vol. 2, Mar.-Apr. 1966, p. 8-16. 9 refs.
Translation.
Computation of the energy distribution over randomly oriented elements of the radiation receiving surface of the hollow collector of a concentrator-type solar device. The energy distribution characteristics in the specular reflection field of a real paraboloidal concentrator are fully established by a structural solution of the energy transfer and distribution problem. Expressions for the radial and axial components of the reflected radiation vector are given, together with expressions which enable the more general laws of radiation field theory to be applied to the field specularly reflected from the paraboloidal mirror of a solar device. Radiant flux measurements necessary to the investigation of the structural characteristics of the concentration field are made, using the calorimetric method. It is shown that the level and distribution of energy over the elements of the collector wall constitute the prime factor in thermal regime optimization of the collectors under consideration. M.G.

A69-27465 #
GALLIUM ARSENIDE PHOTOELECTRIC DETECTION DEVICES [ARSENOWO-GALOWE FOTOELEKTRYCZNE PRZYRZĄDY ODBIORCZE].
Michał Korwin-Pawłowski (Polska Akademia Nauk, Instytut Technologii Elektronowej, Warsaw, Poland).
Przegląd Elektroniki, vol. 10, no. 3, 1969, p. 105-116. 18 refs.
In Polish.
Review of the present state of knowledge of gallium arsenide photoelectric devices for radiation detection and light-to-electric energy conversion. The design, fabrication techniques, and properties of various kinds of photoresistors, photodiodes, and solar cells made of GaAs are described. Z.W.

A69-29261 #
ACTION OF RADIATION ON THE FUNCTIONING OF THERMIONIC CONVERTERS - CONVERSION OF SOLAR RADIATION [ACTION DU RAYONNEMENT SUR LE FONCTIONNEMENT DE CONVERTISSEURS THERMOIONIQUES - CONVERSION DU RAYONNEMENT SOLAIRE].
J. P. David and F. Floret (Aix-Marseille, Université, Faculté des Sciences, Marseille, France).
IN: INTERNATIONAL CONFERENCE ON THERMIONIC ELECTRICAL POWER GENERATION, 2ND, STRESA, ITALY, MAY 27-31, 1968, PROCEEDINGS.
Conference sponsored by the European Nuclear Energy Agency.
Luxembourg, EURATOM Center for Information and Documentation (EUR No. 4210 f, e), 1969, p. 1219-1224. 6 refs. In French.
Study of the possibility of displacing the functioning point of a cesium thermionic converter by causing the interaction of a visible or near-ultraviolet radiation with alkaline atoms to complete neutralization of the space charge by creation of supplementary ions. Various mechanisms are examined: direct photoionization, ionization by stages, ionization by electrons, and action on surface ionization. Experimentally, two effects were observed while illuminating the interelectrode space of the converter with the radiation issuing from a flash on xenon: a reversible effect for low emitter temperature regimes, and an irreversible effect with priming of the arc regime under other conditions of functioning. Solar applications are considered, and a pilot model is described. F.R.L.

A69-30034
EFFICIENCY CALCULATIONS OF HETEROJUNCTION SOLAR ENERGY CONVERTERS.
A. K. Sreedhar, B. L. Sharma, and R. K. Purohit (Solid State Physics Laboratory, Delhi, India).
IEEE Transactions on Electron Devices, vol. ED-16, Mar. 1969, p. 309-312. 17 refs.
Theoretical evaluation of the maximum attainable solar conversion efficiencies of p-n and n-p heterodiodes. The calculations are made for some of the theoretically efficient and feasible heterojunctions of IV and III-V group semiconductors. In these calculations, the Anderson diffusion model is used and carrier concentrations of the two semiconductors are so chosen that photocarriers

generated do not have to surmount any junction barrier. The calculated efficiencies are compared with the reported experimental values and with the conventional Si photovoltaic cell. P.v.T.

A69-31287
THIN FILM SOLAR CELLS FOR BALLOON APPLICATIONS.
Fred A. Shirland (Clevite Corp., Cleveland, Ohio).
IN: INSTRUMENT SOCIETY OF AMERICA, ANNUAL CONFERENCE, 23RD, NEW YORK, N.Y., OCTOBER 28-31, 1968, PROCEEDINGS.

Pittsburgh, Instrument Society of America (Advances in Instrumentation. Volume 23. Part 1), 1968, p. 804 1-804 5.
Description of some recent applications of CdS thin-film solar cells for supplying power for instrumentation and data telemetry on longer-lived balloons. The design of the power systems of meteorological balloons and scientific experimental balloons is outlined. In the last few years, a new type of solar cell has been developed. It is a large-area thin-film device, which is particularly advantageous for balloon applications. It is made from a polycrystalline layer of cadmium sulfide, which is deposited on a metallized plastic film, and is only 4 mils thick. It is flexible enough to withstand repeated bending to less than 1/4-in. radius without damage. Its large size requires fewer cells for a complete system. These attributes make it possible to fabricate large panels that are extremely rugged and reliable. P.v.T.

A69-32797 #
OPTIMUM OPERATING CONDITIONS OF A SOLAR THERMOELECTRIC GENERATOR WITH THERMAL CONTACTS [OPTIMAL'NYI REZHIM RABOTY SOLNECHNOGO TERMOELEKTROGENERATORA PRI NALICHII TEPLOVYKH KONTAKTOV].
B. Arazmedov (Akademiia Nauk Turkmenskoi SSR, Fiziko-Tekhnicheskii Institut, Ashkhabad, Turkmen SSR).
Geliotekhnika, no. 2, 1969, p. 3-8. In Russian.
Discussion of the inflence of thermal contacts on the optimum operating conditions of a solar thermoelectric power generator, with particular reference to the thermal and electric losses arising due to the low thermal conductivity coefficient of the insulating layers between the panels and the thermopile. A heat balance equation for determining the temperature at the cold side of the junction is derived which takes into account the thermal contacts and the thermal resistance of the insulating layers between the thermocouples. Graphs showing the optimum concentration of solar rays as a function of the junction temperature are included. V.P.

A69-32798 #
REFLECTOR CHARACTERISTICS OF A SOLAR POWER INSTALLATION WITH PHOTOELECTRIC CONVERTERS [KHARAKTERISTIKI KONTSENTRATORA SOLNECHNOI ENERGETICHESKOI USTANOVKI S FOTOPREOBRAZOVATELIAMI].
B. Ia. Rodichev and B. V. Tarnizhevskii (Vsesoiuznyi Nauchno-Issledovatel'skii Institut Istochnikov Toka, Kishinev, Moldavian SSR).
Geliotekhnika, no. 2, 1969, p. 9-15. In Russian.
Discussion of the characteristics of a faceted reflector used in solar power installations with photoelectric converters. The analysis is performed for a reflector consisting of thirteen 50-mm facets arranged along the half-width of a parabola. The efficiency and energy balance of the reflector are determined. Optimization considerations indicate that the reflector efficiency can be increased from 0.75 to 0.8. V.P.

A69-32799 #
ANALYSIS OF RADIANT TRANSFER PROCESSES IN CYLINDRICAL CAVITY-TYPE RECEIVERS OF SOLAR INSTALLATIONS [ANALIZ PROTSESSOV LUCHISTOGO OBMENA V TSILINDRICHESKIKH POLOSTNYKH PRIEMNIKAKH GELIOUSTANOVOK].
V. A. Grilikhes and F. V. Obtemperanskii.
Geliotekhnika, no. 2, 1969, p. 40-48. 18 refs. In Russian.
Theoretical and experimental study of the influence of reradiation and multiple reflection on the distribution of the resulting radiant fluxes in cylindrical receivers of solar power installations. It is shown that, at moderate operating temperatures, the flux density distribution over the receiving surface is almost unaffected either by the self-radiation of the receiver walls or by the wall temperature variations. The main radiant losses in such receivers are due to reflection from the cavity, so that a low wall reflection coefficient is desirable. Cavity aspect ratios between 3 and 4 are optimum for minimizing radiant losses. V.P.

A69-33795
SOLAR CONCENTRATION POWER AND OPTIMIZATION OF THE CAVITY TYPE HEATER FOR A SOLAR SOURCE.
Widen Tabakoff (Cincinnati, University, Dept. of Aerospace Engineering, Cincinnati, Ohio).
Raumfahrtforschung, vol. 13, May-June 1969, p. 107-111. 6 refs.
Review of solar power technology and study of an idealized concentrator-absorber system. The flux distribution in the focal plane is derived, and the opening of the cavity is determined for the maximization of the absorbed energy. The maximum achievable temperature of the cavity is found. A numerical example is presented. (Author)

A69-35056 #
LARGE SOLAR ARRAYS - THE EMERGING SPACE POWER WORKHORSE.
J. E. Boretz, Sr. (TRW Systems Group, Redondo Beach, Calif.).
IN: SPACE, TECHNOLOGY, AND SOCIETY; CANAVERAL COUNCIL OF TECHNICAL SOCIETIES, SPACE CONGRESS, 6TH, COCOA BEACH, FLA., MARCH 17-19, 1969, PROCEEDINGS. VOLUME 2.

Edited by L. E. Jones, III.
Cape Canaveral, Fla., Canaveral Council of Technical Societies, 1969, p. 2-1 to 2-18. 16 refs.
Study of the technological problems associated with long-duration solar-array operations in space. The main emphasis is upon identifying the challenges confronting the solar array designer rather than providing specific solutions. Current technical approaches being taken are outlined, and their effectiveness in enhancing the technology readiness of solar array systems is discussed. The discussion is confined to a review of technological problems which are related to the performance and design of cell-stack, substrate, and related power distribution elements. V.P.M.

A69-35679
IMPURITY PHOTOVOLTAIC EFFECT IN SILICON.
G. Güttler and H. J. Queisser (Frankfurt, Universität, Physikalisches Institut, Frankfurt am Main, West Germany).
IN: INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, PHOTOVOLTAIC SPECIALISTS CONFERENCE, 7TH, PASADENA, CALIF., NOVEMBER 19-21, 1968, CONFERENCE RECORD.
New York, Institute of Electrical and Electronics Engineers, Inc., 1968, p. 1-8. 15 refs.
Impurity photovoltaic effect of the gold donor level in silicon has been observed. The spectral response of the open circuit voltage was measured with a lock-in technique. The optical cross section for the transition from that level to the conduction band was determined. Generalization to any deep center was made in view of solar cell performance. It is concluded that no improvement of solar cell efficiency can be achieved by doping with deep traps, because the additional utilization of low-energy photons is overcompensated by an enhanced minority carrier recombination. (Author)

A69-35691 *
CHARACTERISTICS OF SOLAR CELLS AT LOW TEMPERATURES.
Robert J. Lambert (U.S. Navy, Office of Naval Research, Naval Research Laboratory, Washington, D.C.).
IN: INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, PHOTOVOLTAIC SPECIALISTS CONFERENCE, 7TH,

PASADENA, CALIF., NOVEMBER 19-21, 1968, CONFERENCE RECORD.
New York, Institute of Electrical and Electronics Engineers, Inc., 1968, p. 97-100.
NASA-supported research.

Study of a group of solar cells comprising 1 ohm-cm p/n, 1 ohm-cm n/p, and 10 ohm-cm n/p types, at temperatures from 82 to 300 deg K and at light intensities from approximately 1 to 140 mW/sq cm. Efficiencies increased as temperature decreased from 300 to 85 deg K, except at low intensity. Cell efficiency at low temperatures is at least equal to that measured at 300 deg K. Increases up to 73.6% are observed, with efficiencies of 16.1% measured at 140 mW/sq cm and 85 deg K. (Author)

A69-35707
LARGE SOLAR ARRAY DEVELOPMENT IN U.K.
F.C. Treble (Ministry of Technology, Royal Aircraft Establishment, Farnborough, Hants., England).
IN: INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, PHOTOVOLTAIC SPECIALISTS CONFERENCE, 7TH, PASADENA, CALIF., NOVEMBER 19-21, 1968, CONFERENCE RECORD.
New York, Institute of Electrical and Electronics Engineers, Inc., 1968, p. 226-233. 6 refs.

Aspects of large solar array technology, with particular reference to the development of an experimental 560-W deployable array, which has some novel features. The array consists of very thin silicon solar cells mounted on Kapton polyimide film. It is stowed by folding the Kapton concertina-fashion into rectangular compartments and deployed by pneumatically actuated telescopic masts. Deployment is initiated by duplicated pyrotechnic actuators and takes about two minutes to complete. The estimated all-up weight of the 78-sq ft array (including stowage compartments, cushioning, and deployment mechanism) is 25.2 lb, giving a power/weight ratio of 22.3 W/lb at 55 deg C. The main problem areas are discussed in some detail, with an indication of the progress made to date. (Author)

A69-35708
SOLAR ARRAYS UTILIZING LARGE AREA SILICON SOLAR CELLS.
J. D. Gum, E. D. Steele, R. L. Oliver, and E. L. Ralph (Textron, Inc., Sylmar, Calif.).
IN: INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, PHOTOVOLTAIC SPECIALISTS CONFERENCE, 7TH, PASADENA, CALIF., NOVEMBER 19-21, 1968, CONFERENCE RECORD.
New York, Institute of Electrical and Electronics Engineers, Inc., 1968, p. 234-242.

When production of large-area silicon solar cells appeared practical, an investigation was initiated into their characteristics to develop systems and techniques allowing utilization of their special qualities. One hundred thousand cells later, the results show comparable reliability to 2 x 2 cm cell arrays but with lower costs. Effects of thermally caused differential dimensional changes can be minimized or eliminated through proper design. Where panel sizes permit, large-area cells provide advantages. (Author)

A69-35709
ELECTRICAL OUTPUT OF SHADOWED SOLAR ARRAYS.
H. S. Rauschenbach (TRW Systems Group, Redondo Beach, Calif.).
IN: INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, PHOTOVOLTAIC SPECIALISTS CONFERENCE, 7TH, PASADENA, CALIF., NOVEMBER 19-21, 1968, CONFERENCE RECORD.
New York, Institute of Electrical and Electronics Engineers, Inc., 1968, p. 243-252. 15 refs.

The effects of shadows on the current-voltage characteristics of solar cell circuits are studied and used for the development of several mathematical models. These models describe circuits of any geometry with or without shunt or blocking diodes. For efficient analyses of larger arrays, the concept of the shadowing factor is developed. All models are useful in analyses performed by hand or digital computer, using theoretical or empirical input data. (Author)

A69-36418 * #
STATUS OF PHOTOVOLTAIC POWER TECHNOLOGY.
Arvin Smith (NASA, Washington, D.C.).
(American Society of Mechanical Engineers, Winter Annual Meeting and Energy Systems Exposition, New York, N.Y., Dec. 1-5, 1968, Paper 68-WA/Sol-1.)
ASME, Transactions, Series A—Journal of Engineering for Power, vol. 91, Jan. 1969, p. 1-12. 77 refs.

Review of the status of photovoltaic power technology primarily from the viewpoint of current and future applications to the exploration and use of space. The photovoltaic-solar cell technology has shown steady improvement in reliability, increased efficiency, reduced cost, increased power per unit of hardware weight, and ability to withstand extremes of the space environment. New developments are underway to increase solar-cell and array size, to reduce stowage volume during boosting into orbit, and to improve resistance to space radiation and thermal cycling. Silicon-cell electrical contacts and interconnections, low-energy proton damage to small exposed cell areas, and instability of CdS thin-film solar cells are examples of problems receiving attention at this time. M.M.

A69-42271
A TECHNIQUE FOR IDENTIFYING THE CAUSE OF PERFORMANCE DEGRADATION IN CADMIUM SULFIDE SOLAR CELLS.
K. L. Kennerud (Boeing Co., Seattle, Wash.).
IN: AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, INTERSOCIETY ENERGY CONVERSION ENGINEERING CONFERENCE, 4TH, WASHINGTON, D.C., SEPTEMBER 22-26, 1969, PROCEEDINGS.
Conference co-sponsored by the American Institute of Aeronautics and Astronautics, the American Nuclear Society, the American Society of Mechanical Engineers, the American Chemical Society, the Institute of Electrical and Electronics Engineers, and the Society of Automotive Engineers.
New York, American Institute of Chemical Engineers, 1969, p. 561-566.

Calculation of the effect of changes in five physically meaningful parameters on the current-voltage curve of a CdS solar cell. Comparisons between the calculated data and performance data obtained from degraded solar cells are made. The parameter that changed to cause the degradation in each cell becomes apparent. (Author)

A69-42273
THE "HOT SPOT" FAILURE MODE FOR SOLAR ARRAYS.
F. A. Blake and K. L. Hanson (General Electric Co., Valley Forge Space Center, Philadelphia, Pa.).
IN: AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, INTERSOCIETY ENERGY CONVERSION ENGINEERING CONFERENCE, 4TH, WASHINGTON, D.C., SEPTEMBER 22-26, 1969, PROCEEDINGS.
Conference co-sponsored by the American Institute of Aeronautics and Astronautics, the American Nuclear Society, the American Society of Mechanical Engineers, the American Chemical Society, the Institute of Electrical and Electronics Engineers, and the Society of Automotive Engineers.
New York, American Institute of Chemical Engineers, 1969, p. 575-581.

Description of the "hot spot" phenomenon, and evaluation of the results of investigations on the amount of heating and temperature rise that are expected in solar arrays. It is pointed out that the potentially destructive "hot spot" phenomenon is due to a small fault in a solar array series element. The fault produces a perfor-

mance anomaly which switches the element from a power generator to a power dissipator in which all of the functioning illuminated cells within the element overheat. The severity of the heating is dependent on solar array operating conditions and design configuration. The most effective protection against this failure mode is to produce control of the I-V characteristic performance in the negative-voltage quadrant through use of bypass diodes. Z.W.

A70-10750
SEMICONDUCTOR SOLAR ENERGY CONVERTERS.
Edited by V. A. Baum (Akademiia Nauk Turkmenskoi SSR, Fiziko-Tekhnicheskii Institut, Ashkhabad, Turkmen SSR).
(Translation of Preobrazovateli Solnechnoi Energii na Poluprovodnikakh, Moscow, Izdatel'stvo Nauka, 1968.)
New York, Consultants Bureau, 1969. 229 p.
$27.50.

CONTENTS:

A70-10751

EXPERIMENTAL SOLAR THERMOELECTRIC GENERATOR.

G. A. Alatyrtsev, V. A. Baum, Iu. N. Malevskii, and N. G. Milevskaia (Gosudarstvennyi Nauchno-Issledovatel'skii Energeticheskii Institut, Moscow, USSR).

IN: SEMICONDUCTOR SOLAR ENERGY CONVERTERS.

Edited by V. A. Baum.

(Translation of Preobrazovateli Solnechnoi Energii na Poluprovodnikakh, Moscow, Izdatel'stvo Nauka, 1968.)

New York, Consultants Bureau, 1969, p. 3-8.

Description of a semiconductor thermoelectric generator with a structure which facilitates the replacement of faulty thermoelements during service. The generator, which is convenient to assemble, consists of 25 series-connected thermoelements whose arms have a total cross-sectional area of 39 sq cm. The thermoelements are made from p- and n-type alloys based on selenium and lead. The generator is designed to operate in the temperature range from 50 to 450 deg C. The upper temperature level is selected on the basis of the stability of the working material in air for an acceptable value of the product zT (0.5 to 0.6). Diffused joints are used between the metal straps and the semiconductors. Tests using natural (solar) radiation were carried out with a paraboloid concentrator of 1.4-m diameter. The temperature distribution over the surface of the hot junctions placed in the focal plane of the concentrator, the output power, and the efficiency of the generator were determined. (Author)

A70-10752

POWER CHARACTERISTICS OF A SOLAR THERMOELECTRIC GENERATOR.

M. Gaibnazarov, Iu. N. Malevskii, and I. A. Rezgol' (Gosudarstvennyi Nauchno-Issledovatel'skii Energeticheskii Institut, Moscow, USSR).

IN: SEMICONDUCTOR SOLAR ENERGY CONVERTERS.

Edited by V. A. Baum.

(Translation of Preobrazovateli Solnechnoi Energii na Poluprovodnikakh, Moscow, Izdatel'stvo Nauka, 1968.)

New York, Consultants Bureau, 1969, p. 9-14. 5 refs.

Theoretical analysis of the output parameters of a cascaded solar thermoelectric generator (STEG). The conditions for maximum efficiency of a STEG are considered, and a method is suggested for the determination of the optimum temperature of the hot junctions of the thermoelements as a function of the concentration of solar radiation. The current-voltage characteristic of a STEG is analyzed for a constant heat flux from a source. Calculations show that, within the limits of the load characteristic of a STEG, a change in the temperature of the hot junction gives rise to a considerable nonlinearity in the current-voltage characteristic. The value of the voltage across the load, corresponding to the maximum output power and efficiency, is less than half the open-circuit voltage. (Author)

A70-10761

THERMAL CONDITIONS IN CYLINDRICAL CAVITY ABSORBERS OF HIGH-TEMPERATURE SOLAR ENERGY CONVERTERS.

R. A. Zakhidov and D. I. Tepliakov (Gosudarstvennyi Nauchno-Issledovatel'skii Energeticheskii Institut, Moscow, USSR).

IN: SEMICONDUCTOR SOLAR ENERGY CONVERTERS.

Edited by V. A. Baum.

(Translation of Preobrazovateli Solnechnoi Energii na Poluprovodnikakh, Moscow, Izdatel'stvo Nauka, 1968.)

New York, Consultants Bureau, 1969, p. 134-142. 11 refs.

Study of the problem of the optimization of the geometry of cavity absorbers from the point of view of the absorption parameters of the radiation (density level and nature of the distribution along wall surfaces) reflected by a concentrator. The problem of the optimization of the geometry is related to the thermal conditions in the absorber—i.e., to the possibility of heat transfer by conduction along the walls. An analysis based on certain assumptions about the structure of the radiation field and on the results of specially conducted experiments shows that, to obtain optimum average intensities of the radiation incident along the bottom and side walls of a cylindrical absorber, the optimum ratio should be $l/d \approx 1$ (l is the depth and d is the diameter of the absorber). The distribution of the local radiant flux incident on various parts of an absorber is investigated. (Author)

A70-10762

TRANSPORT AND DISTRIBUTION OF RADIATION IN SOLAR ENERGY UNITS WITH MIRROR CONCENTRATORS.

D. I. Tepliakov (Gosudarstvennyi Nauchno-Issledovatel'skii Energeticheskii Institut, Moscow, USSR).

IN: SEMICONDUCTOR SOLAR ENERGY CONVERTERS.

Edited by V. A. Baum.

(Translation of Preobrazovateli Solnechnoi Energii na Poluprovodnikakh, Moscow, Izdatel'stvo Nauka, 1968.)

New York, Consultants Bureau, 1969, p. 143-166. 35 refs.

Review and analysis of several theoretical solutions for the concentration of direct solar radiation by paraboloid mirrors. It is shown that complete allowance for mirror imperfections can be made using equivalent but different methods of solution, based on the assumption that the imperfections of the reflecting surfaces of solar energy concentrators are distributed statistically (at random). Energy transport and distribution functions in the concentration field of radiant energy are introduced and commented on. A generalized system for measuring coordinates, radiant fluxes, and radiation density is discussed. The limits of validity of ideal (simplified) methods are established. (Author)

A70-10763

ENERGY CHARACTERISTICS OF SOLAR UNITS WITH MIRRORS UNDER SERVICE CONDITIONS.

D. I. Tepliakov (Gosudarstvennyi Nauchno-Issledovatel'skii Energeticheskii Institut, Moscow, USSR).

IN: SEMICONDUCTOR SOLAR ENERGY CONVERTERS.

Edited by V. A. Baum.

(Translation of Preobrazovateli Solnechnoi Energii na Poluprovodnikakh, Moscow, Izdatel'stvo Nauka, 1968.)

New York, Consultants Bureau, 1969, p. 167-182. 18 refs.

Consideration of the influence of inaccurate positioning of an absorber in a concentrating solar-unit mirror on the energy parameters of the unit. Transverse defocusing, consisting of a shift of a circular absorber along the focal plane of a mirror concentrator, is considered. Longitudinal defocusing, which represents a shift of the absorber along the optical axis, and defocusing due to angular misalignment, with the absorber positioned at an angle to the focal plane, are also discussed. The energy parameters of units with complex (composite) optical systems, including one or more heliostats, are analyzed. The results, obtained by computer calculations, are presented graphically in a generalized system for measuring coordinates, radiant fluxes, and their densities, so that they can be applied to mirrors of various dimensions and arbitrary quality. (Author)

A70-10764

INVESTIGATIONS OF HIGH-TEMPERATURE SOLAR ENERGY ABSORBERS AND THERMAL STORAGE DEVICES.

V. I. Baranov, G. F. Muchnik, and S. N. Trushevskii (Gosudarstvennyi Nauchno-Issledovatel'skii Energeticheskii Institut, Moscow, USSR).

IN: SEMICONDUCTOR SOLAR ENERGY CONVERTERS.

Edited by V. A. Baum.

(Translation of Preobrazovateli Solnechnoi Energii na Poluprovodnikakh, Moscow, Izdatel'stvo Nauka, 1968.)

New York, Consultants Bureau, 1969, p. 183-189. 9 refs.

Results of theoretical and experimental investigations of solar-energy absorbers and thermal storage devices intended for use in high-temperature converters of solar energy into electrical power by thermionic or thermoelectric methods. Experiments were carried out on absorbers in the form of a hemisphere, sphere, and cylinder, using solar radiation and a laboratory light source imitating solar radiation. The possibility of constructing absorbers with an even temperature distribution along the walls is considered. The thermal storage devices described operate on the principle of the use of the latent heat of phase transitions Q_{ph}. A mathematical statement of the problem is given, together with the results of calculations (carried out using an electronic computer) of the thermal and geometrical parameters of thermal storage devices. Chemical and thermal storage devices are compared. Thermal storage materials with Q_{ph} equal to 150 J/kg have been found, and attempts are being made to increase this value. (Author)

A70-10767

APPLICATIONS OF SELECTIVE COATINGS IN SOLAR THERMOELECTRIC GENERATORS.

L. N. Vladimirova, B. A. Garf, and A. V. Sheklein (Gosudarstvennyi Nauchno-Issledovatel'skii Energeticheskii Institut, Moscow, USSR).
IN: SEMICONDUCTOR SOLAR ENERGY CONVERTERS.

Edited by V. A. Baum.
(Translation of Preobrazovateli Solnechnoi Energii na Poluprovodnikakh, Moscow, Izdatel'stvo Nauka, 1968.)
New York, Consultants Bureau, 1969, p. 209-215. 12 refs.

Description of a method for making thermal calculations of solar energy units of the "hot box" type with an ordinary glass insulation and with selective glasses which reflect strongly the long-wavelength radiation of a hot absorber. Results are given of a comparative analysis, showing that the use of selective glasses is to be recommended, particularly at the elevated temperatures of an absorber (80 deg C or higher). Such glasses can be recommended for solar thermoelectric generators working without solar radiation concentrators. It is shown that at relatively low temperatures, such as those used in heating water for shower baths, the use of selective glass is not justified, since in this case the radiant heat losses are relatively low and their reduction by selective insulation results in a reduction of transmission of the short-wavelength radiation through the insulation. (Author)

A70-11932 * #

DEPLOYMENT TECHNIQUES DEVELOPED FOR LARGE AREA ROLL-OUT SOLAR ARRAYS.

W. A. Hasbach (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.).
IN: AEROSPACE STRUCTURES DESIGN CONFERENCE, SEATTLE, WASH., AUGUST 4, 5, 1969, PROCEEDINGS.

Conference sponsored by the Seattle Professional Engineering Employees Association, the American Institute of Aeronautics and Astronautics, the Boeing Co., the University of Washington, and the Pacific Science Center.
Seattle, Wash., Seattle Professional Engineering Employees Association, 1969, p. 1-1 to 1-12.

Description of a feasibility study which has been performed to determine deployment systems which could extend large-area, lightweight, flexible solar arrays in space. The estimated weight for each design concept, including the estimated power-to-weight ratio, is tabulated. In the stowed configuration, the array must occupy a minimum of area within the shroud envelope and, upon command, extend at a uniform rate into the deployed position. The manufacturing technology is limited to modest extensions of the existing state of development. M.M.

A70-12080

NEW METHODS FOR THE FABRICATION OF SOLAR ARRAYS (NEUE TECHNOLOGISCHE VERFAHREN FÜR SOLARZELLEN-ANLAGEN).

E. Suppa, J. Heinecke, F. Köhler, and E. Müller (Messerschmitt-Bölkow-Blohm GmbH, Munich, West Germany).
Raumfahrtforschung, vol. 13, Sept.-Oct. 1969, p. 205-212. 10 refs. In German.
Research supported by the Bundesministerium für Wissenschaftliche Forschung.

Description of some new advanced methods for the fabrication of solar arrays, which make it possible to extend the operating temperature up to 200 deg C by the use of spot welding techniques and the deletion of adhesives. Various problems associated with the solar array construction are reviewed, and new possibilities in the fabrication of modules are demonstrated. They include primarily a new pulsed welding technique which allows overall improvements in reliability, weight, and cost, as well as the use of silicon cells in flexible roll-out and fold-out arrays. O.H.

A70-15329

ANALYSIS OF PERFORMANCE DEGRADATION IN CdS SOLAR CELLS.

Kenneth L. Kennerud (Boeing Co., Aerospace Systems Div., Seattle, Wash.).
(AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, INTERSOCIETY ENERGY CONVERSION ENGINEERING CONFERENCE, 4TH, WASHINGTON, D.C., SEPTEMBER 22-26, 1969, PROCEEDINGS, p. 561-566.)
IEEE Transactions on Aerospace and Electronic Systems, vol. AES-5, Nov. 1969, p. 912-917.

Calculation of the effect of changes in five physically meaningful parameters on the current-voltage curve of a CdS solar cell. Comparisons between the calculated data and performance data obtained from degraded solar cells are made. The parameter that changed to cause the degradation in each cell becomes apparent. (Author)

A70-16724

NEW DEVELOPMENTS IN THE FIELD OF SOLAR CELLS (NEUERUNGEN AUF DEM GEBIET DER SOLARZELLEN).

Internationale Elektronische Rundschau, vol. 23, Dec. 1969, p. 319, 320. In German.

Discussion of a new improved solar cell developed to overcome the limitations of the present standard solar cell when subjected to extreme temperature fluctuations. The dimensions of the new cell, called the Telesun solar cell, are 6 by 2 by 0.014 cm. The new cells are well-suited for the construction of solar cell generators. Experiments leading to the development of improved contacts, including the wraparound contact, are discussed. G.R.

A70-19623 #

EMPIRICAL EQUATION FOR THE EXTERNAL CHARACTERISTIC OF A PHOTOELECTRIC SOLAR GENERATOR (EMPIRICHESKOE VYRAZHENIE DLIA VNESHNEI KHARAKTERISTIKI SOLNECHNOGO FOTOELEKTRICHESKOGO GENERATORA).

A. T. Belenov, K. E. Koshkin, and B. V. Tarnizhevskii.
Geliotekhnika, no. 5, 1969, p. 6-10. In Russian.

Derivation of an empirical equation determining the external current-voltage characteristic of a composite multicell solar energy converter generating a power of 0.2 to 0.5 kW. This characteristic is a parameter of the entire composite system and is defined as a certain function of the combination of the current-voltage characteristics of the individual components cells of the converter. Fair agreement is obtained between current-voltage characteristics calculated with the aid of this equation and experimental characteristics, for two different geographical locations. V.Z.

A70-19625 #

MECHANICAL TREATMENT OF THE COLLECTOR SURFACES OF SOLAR INSTALLATIONS FOR IMPROVING THE SELECTIVITY OF OPTICAL PROPERTIES (MEKHANICHESKAIA OBRABOTKA KOLLEKTORNYKH POVERKHNOSTEI GELIOU-

STANOVOK DLIA POLUCHENIIA POVYSHENNOI SELEKTIVNOSTI OPTICHESKIKH SVOISTV).
M. D. Kudriashova (Gosudarstvennyi Nauchno-Issledovatel'skii Energeticheskii Institut, Moscow, USSR).
Geliotekhnika, no. 5, 1969, p. 36-39. 7 refs. In Russian.

Investigation of the possibility of improving the selectivity of the optical properties of solar installations by mechanical treatment of their light-collecting surfaces before coating. Grinding of copper and Duralumin plates with a variety of finely-divided abrasive powders is carried out to obtain desirable diffusely reflecting surfaces. A brand of diamond powder with 1 mu particles is found to provide the best results on Duralumin while a dry abrasive with 7 mu particles was most effective on copper. V.Z.

A70-21721 **Calculated efficiencies of practical GaAs and Si solar cells including the effect of built-in electric fields.** B. Ellis and T. S. Moss (Royal Aircraft Establishment, Farnborough, Hants., England). *Solid-State Electronics,* vol. 13, Jan. 1970, p. 1-24. 28 refs.

The performance of GaAs solar cells has been calculated as a function of the doping levels, using practical values for the transport parameters. Calculations show that surface recombination is a more probable cause than recombination in the junction region of the poor efficiencies obtained in practice. Electric fields built into the cell by doping gradations may be used to reduce surface losses and produce an efficiency exceeding 20 per cent for a surface recombination velocity of 10 km/sec. This figure allows for the finite resistance of the surface layer, the effect of which is considered in detail for several cases. Results for Si cells are also presented. These are well in accord with the values obtained in practice. For both materials consideration is given to the degradation brought about by particle bombardment. (Author)

A70-22050 **Solar cells.** M. W. Ranney. Park Ridge, N.J., Noyes Development Corp., 1969. 285 p. $35.

The detailed, descriptive information in this book is based on U.S. patents relating to solar cells. The book serves a double purpose in that it supplies detailed technical information, and can be used as a guide to the U.S. Patent literature in this field. Silicon semiconductors are considered taking into account silicon-metal alloys. Cell panel fabrication techniques are discussed and progress made concerning semiconductors using cadmium or gallium compounds is examined. Advances in the use of organic semiconductors and in the use of photoemissive devices for solar cell application are included. Some miscellaneous applications are discussed relating to position detection in space and to control requirements for plant growth regulation. G.R.

A70-23522 * # **Optics at the Lewis Research Center.** D. R. Buchele (NASA, Lewis Research Center, Cleveland, Ohio). *Applied Optics,* vol. 9, Feb. 1970, p. 399-403. 71 refs.

A survey is presented of the applications of optics to research at the NASA Lewis Research Center. The Center's principal research areas are flight propulsion and space power generation; these use optical devices and techniques in photography, gas density visualization, pyrometry of gases and surfaces, radiative heat transfer studies, spectroscopy, spectroradiometry, solar simulation, and solar-cell development for space applications. (Author)

A70-25434 # **Oriented flexible rolled-up solar array.** George Wolff (Hughes Aircraft Co., Space Systems Div., Culver City, Calif.). *American Institute of Aeronautics and Astronautics, Communications Satellite Systems Conference, 3rd, Los Angeles, Calif., Apr. 6-8, 1970, Paper 70-738.* 11 p. Members, $1.00; nonmembers, $1.50.

This paper describes the operation of and the components of the large oriented flexible rolled-up solar array as well as advances in subcomponent technology. The components described are the orientation mechanism, solar panel, and deployment mechanism. (Author)

A70-29554 **Solar generators and solar cells (Solargeneratoren und Solarzellen).** Hans-Walter Boller, Rolf Buhs, Hans-Joachim Dürre, and Günter Mohns. *AEG-Telefunken, Technische Mitteilungen,* vol. 60, no. 2, 1970, p. 85, 86. In German.

Discussion of the principal requirements posed to solar cells and solar cell array, as a function of the illumination conditions, the satellite orbit, and the geometry and type of stabilization of the satellite. In addition, cells and arrays must be designed for high accelerations, vibration, mechanical shock, and for the influence of vacuum, extreme temperatures, extreme and rapid temperature variations, UV and corpuscular radiation, and micrometeorite impact. Some solutions obtained for several satellite projects are noted. V.P.

A70-30907 **High temperature phase studies with a solar furnace.** Tetsuo Noguchi (Government Industrial Research Institute, Nagoya, Japan). In: Advances in high temperature chemistry. Volume 2. Edited by LeRoy Eyring. New York, Academic Press, Inc., 1969, p. 235-262. 65 refs.

Review of the state of art concerning high temperature studies on solid-solid reactions and solid-liquid or condensed phase-gas equilibria, using a solar furnace. The optical system, structure and types of solar furnaces are described together with irradiation techniques and attainable temperatures. The methods used for temperature and emissivity measurements are reviewed. The freezing points of the high-melting point refractory oxides were determined. Special attention is given to the phase studies at high temperatures including determination of the liquidus curves, high temperature reactions, vaporization and rate studies, and determination of phase diagrams of high-melting point oxides. Z.W.

A70-31600 # **Biological problems of solar energy conversion (Biologicheskie problemy preobrazovaniia solnechnoi energii).** A. A. Shakhov (Akademiia Nauk SSSR, Institut Fiziologii Rastenii, Moscow, USSR). *(Vsesoiuznaia Konferentsiia po Ispol'zovaniiu Solnechnoi Energii, Yerevan, Armenian SSR, July 19, 1969.) Geliotekhnika,* no. 6, 1969, p. 41-54. 30 refs. In Russian.

Survey of the current state of knowledge about photosynthesis and nonphotosynthesis mechanisms of biological conversion of solar energy. The three stages of photosynthesis are examined; these include (1) the separation of hydrogen from the water molecule and the liberation of oxygen, (2) transfer of hydrogen with the aid of energy trapped by chlorophyll, and (3) use of the oxygen to reduce carbon dioxide to carbon. The nonphotosynthesis conversion process is relatively lightly studied, but it is reliably known that it is partially caused by free-radical processes. Data available in the literature are analyzed, and attention is given to artificially created photochemical conversion systems. T.M.

A70-32424 # **Measurements of temperatures of products treated in a solar furnace by means of IR pyrometers (Mesure des températures des produits traités au four solaire à l'aide de pyromètres infra rouge).** M. Foex, J. P. Coutures, and G. Benezech. *(Coopération Méditerranéenne pour l'Energie Solaire, Rencontre Générale, Athens, Greece, Sept. 8-13, 1969.) Coopération Méditerranéenne pour l'Energie Solaire, Bulletin* no. 18, Apr. 1970, p. 67-77. 18 refs. In French.

Study of the advantages and drawbacks concerning the use of IR pyrometers for measuring temperatures of products treated in a solar furnace. It is shown that by employing certain interference filters, the temperatures ranging from 2000 to 3500 deg C can be measured by means of optical pyrometers if the parasitic effects due to reflections of the solar radiation are eliminated. Problems concerning the determination of radiation factors when the black body can not be used are discussed. Z.W.

A70-32425 # **Feasible energy and technical characteristics of solar thermoelectric generator (STEG) with two-stage converter.** V. A. Baum, M. Gaibnazarov, and Iu. N. Malevsky. *(Coopération*

Méditerranéenne pour l'Energie Solaire, Rencontre Générale, Athens, Greece, Sept. 8-13, 1969.) Coopération Méditerranéenne pour l'Energie Solaire, Bulletin no. 18, Apr. 1970, p. 115-122. 9 refs.

Survey of the theoretical and practical developments concerning the solar thermoelectric converter with two-stage circuit. It is pointed out that the main factor which determines the efficiency of a thermoelectric converter is the heat flux on the surface of hot junction. Use of modern semiconductor materials makes it possible to develop a converter having the weight characteristics of the order of 10 kg/kW. The efficiency actually obtained under laboratory conditions at about 900 deg K attains 11% when a two stage circuit is used. Higher concentrations of the radiant flux make it possible to improve the characteristics of this converter and reduce the required frontal area of the concentrator. Z.W.

A70-34131 * # **Thermal Heliotrope - A passive sun-tracker.** R. C. Byxbee and D. R. Lott (Lockheed Missiles and Space Co., Sunnyvale, Calif.). In: Aerospace mechanisms. Part A - General applications. Edited by G. G. Herzl. San Francisco, J. W. Stacey, Inc. (Aerospace Mechanisms Series. Volume 1), 1970, p. 283-289. 9 refs. Contract No. NAS 5-11637.

Because of the high cost and mechanical problems associated with large fixed solar arrays, sun tracking is of special interest to aerospace engineers. Moreover, since conventional electromechanical tracking systems have proved to be complicated and expensive, a passive approach is desirable. By utilizing solar energy to activate a bimetal helix, a passive Thermal Heliotrope is possible. This concept has been used successfully for louvers and thermal switches in thermal control. Initial model tests have proved the heliotrope concept, and development work is being performed to establish feasibility. Three types of Thermal Heliotrope are discussed: a reset tracker, an incremental tracker, and a seasonal adjuster. (Author)

A70-36238 # **Heterogeneous solar cells based on polycrystalline cadmium sulfide and selenide (Geterogennye solnechnye preobrazovateli na osnove polikristallicheskogo sul'fida i selenida kadmiia).** V. N. Komashchenko, A. I. Marchenko, and G. A. Fedorus (Akademiia Nauk Ukrainskoi SSR, Institut Poluprovodnikov, Kiev, Ukrainian SSR). *Poluprovodnikovaia Tekhnika i Mikroelektronika,* no. 4, 1970, p. 112-121. 11 refs. In Russian.

Discussion of the characteristics of photocells developed on the basis of cadmium sulfide and selenide. The preparation methods are described, along with the photoelectric and electric properties of these devices. It is shown that they possess a high photosensitivity throughout the visible range of the spectrum. The efficiency of conversion of light to electric energy is about 3%. These photocells exhibit a high parameter stability in time. M.V.E.

A70-40623 * **Heterojunction solar cell calculations.** R. Sahai and A. G. Milnes (Carnegie-Mellon University, Pittsburgh, Pa.). *Solid-State Electronics,* vol. 13, Sept. 1970, p. 1289-1299. 12 refs. Grant No. NGR-39-087-002.

Solar cell efficiencies are computed for feasible semiconductor heterojunction cells of ZnSe-GaAs, GaP-Si, ZnSe-Ge, and GaAs-Ge. The analysis includes the loss in efficiency because of reflection, incomplete collection and internal series resistance. Optimum antireflection films are also calculated. The results are compared with the performances expected of Si solar cells and GaAs homojunction cells. ZnSe-GaAs cells are shown to have the potential for exceeding the efficiency of both Si and GaAs cells, if interface recombination losses are small. The output voltage, voltage regulation and temperature performance should be superior to that of Si cells. The window effect in the heterojunction cell may also provide some inherent resistance to deterioration under radiation conditions. (Author)

A70-41008 **How mechanical requirements affect silicon solar-cell costs.** P. A. Iles and K. S. Ling (Globe-Union, Inc., El Monte, Calif.). In: Space systems and thermal technology for the 70's; American Society of Mechanical Engineers, Space Technology and Heat Transfer Conference, Los Angeles, Calif., June 21-24, 1970, Proceedings. Part 1. New York, American Society of Mechanical Engineers, 1970. 4 p.

N/P solar cells of design presently being produced have been the workhorse for space power for the past six years. Several million cells have been flown and there has been a steady increase in average output per dollar and in cell reliability. The specifications used to select acceptable cells have become more demanding both in electrical output and environmental stability areas and in mechanical and visual requirements. This paper describes typical present-day specifications and discusses how cell costs could be reduced, with no loss of output or reliability, if some of the mechanical and visual requirements were relaxed. (Author)

A70-41010 * **Solar-panel approaches for a Venus-Mercury flyby.** Ronald G. Ross, Jr. (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Space systems and thermal technology for the 70's; American Society of Mechanical Engineers, Space Technology and Heat Transfer Conference, Los Angeles, Calif., June 21-24, 1970, Proceedings. Part 1. New York, American Society of Mechanical Engineers, 1970. 8 p.

If Mercury is at its aphelion (0.43 AU) during encounter, a spacecraft designed to flyby Venus and Mercury will be subjected to solar intensities ranging from 1 to 5 times that at earth. Because flat, fully celled solar panels will exceed their maximum safe operating temperature at intensities greater than 2 or 3 suns, it is necessary to provide some additional means of temperature control. This paper describes the techniques used to evaluate the temperature and power performance of solar-array designs being considered for a 1973 Venus-Mercury mission. Also presented is a comparison of the predicted performances of three candidate designs: the mirror mosaic design, the selective bandpass filter design, and the tilted panel design. (Author)

A70-41852 # **Heat-transfer processes in solar energy storage systems for orbital applications.** Frank Matinek (Vermont, University, Burlington, Vt.). *Journal of Spacecraft and Rockets,* vol. 7, Sept. 1970, p. 1032-1037. 15 refs.

Study of the use of solar energy for power conversion systems for orbital missions, showing that by using heat storage systems utilizing the heat of fusion and the sensible heat of materials such as LiH it should be possible to store the energy collected during the orbital day and to release it during the orbital night. Two versions of such a storage system (a system involving change of phase and a system with fins) are proposed, and their schematic diagrams and mathematical models are examined. The behavior of a heat storage employing the heat of fusion is predicted. The feasibility of synchronizing the thermal cycle with the orbital time is demonstrated, and the limiting operating conditions are determined. V.P.

A70-43537 # **New developments in degradation-resistant CdS solar cells.** L. Clarke, R. Gale, K. Moore, R. J. Mytton, and R. S. Pinder (International Research and Development Co., Ltd., Newcastle-upon-Tyne, England). *Joint Services Electrical Power Sources Committee, International Power Sources Symposium, 7th, Brighton, England, Sept. 15-17, 1970, Paper 38.* 12 p. 12 refs. Research sponsored by the Communications Satellite Corp.

Description of the construction, operation, attractive features and present limitations of CdS thin film solar cells. A description of cell manufacture is given as a background for consideration of the possible degradation mechanisms. Experiments to further characterize the individual mechanisms led to improvements in manufacturing technology to minimize the instabilities. The effect of the operating conditions of the cells on the amount of degradation is discussed. The prospects for CdS cells are reviewed in the light of improvements in stability achieved. M.M.

A70-46325 # **Semiconductor solar energy converters and the phenomenon of photoconductivity quenching (Poluprovodnikovye preobrazovateli solnechnoi energii i iavlenie gasheniia fotoprovodimosti).** M. S. Isamukhamedova and P. M. Karageorgii-Alkalaev (Tashkentskii Gosudarstvennyi Universitet, Tashkent, Uzbek SSR). *Geliotekhnika,* no. 3, 1970, p. 16-19. 6 refs. In Russian.

Theoretical study of the application of semiconductor materials in solar energy converters, with special attention to photoconductivity quenching which may occur when a semiconductor with a wide forbidden band is used for solar energy conversion. A semiconductor model with two impurity levels exchanging current carriers is analyzed to determine the conditions of the occurrence of photoconductivity quenching. Expressions describing this phenomenon are derived. An analysis of these expressions indicates that photoconductivity quenching tends to develop at high temperatures in semiconductors of this type. V.Z.

A71-11896 # **Longwave sensitivity of nCdS-pCu(2-x)S solar converters (Dovgokhvil'ova chutlivist' soniachnikh peretvoriuvachiv n-CdS - p-Cu/2-x/S).** A. I. Marchenko, S. Iu. Pavelets', and G. A. Fedorus (Akademiia Nauk Ukrains'koi RSR, Institut Napivprovidnikiv, Kiev, Ukrainian SSR). *Ukrains'kii Fizichnii Zhurnal,* vol. 15, Sept. 1970, p. 1529-1533. 7 refs. In Ukrainian.

Experimental investigation of the characteristics of photoconverters obtained on the basis of CdS films and having heterojunctions prepared by dipping the films for several seconds into an aqueous solution of CuCl heated to 100 C. Analysis of the spectral distribution of the absorption of Cu(2-x)S films and of the short-circuit photocurrent of the system CdS-Cu(2-x)S showed that the sensitivity of the photoconverters in the longwave region of the spectrum (0.5 to 1 micron) is essentially defined by extrinsic absorption of light in CdS. Extrinsic photo emf was observed only in CdS-based photoelements with a high-resistance surface layer. V.P.

A71-16058 **Integrated high voltage cadmium sulphide solar batteries.** R. J. Mytton, R. S. Pinder, and K. Moore (International Research and Development Co., Ltd., Newcastle-upon-Tyne, England). In: Institute of Electrical and Electronics Engineers, Photovoltaic Specialists Conference, 8th, Seattle, Wash., August 4-6, 1970, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1970, p. 30-32.

A new type of integrated cadmium sulphide solar battery is described which obviates the need for a grid and which generates a high voltage from a single integrated unit. Several such batteries have been constructed, each consisting of seventeen cells formed and interconnected in series within one CdS film. The method of interconnection, involving Cu2S channels within the CdS film, has been established, but further development is required to optimize the efficiency of these devices and realize their full potential. (Author)

A71-16071 * **Low temperature and low solar intensity characteristics of silicon solar cells.** Patricia A. Payne and Eugene L. Ralph (Textron, Inc., Sylmar, Calif.). In: Institute of Electrical and Electronics Engineers, Photovoltaic Specialists Conference, 8th, Seattle, Wash., August 4-6, 1970, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1970, p. 135-141. Contract No. NAS 2-5519.

Demonstration that the efficiencies of N/P silicon solar cells at a solar intensity of 5.0 mW/sq cm and a temperature of -135 C have been greatly improved by forming a P(+) region on the back cell surface to eliminate a metal-semiconductor Schottky barrier at the rear contact. The 'broken knee' effect (a flat spot in the knee portion of an I-V curve) has been observed at low temperatures. It is observed primarily at low intensity; however, if serious enough, it is also present at high intensity. This effect acts like a leakage path which has a threshold voltage of 0.2 to 0.4 V and it seems to be associated primarily with the bar contact region of the solar cell. Cells fabricated from float zone and Mon-X silicon showed an improved linearity of the short circuit current as a function of temperature over cells fabricated from crucible grown silicon. These cells consequently had higher short circuit currents at -135 C and, when the 'broken knee' was absent, exhibited efficiencies of 15 to 17%. (Author)

A71-16099 **Progress in advanced solar array development.** F. C. Treble (Royal Aircraft Establishment, Farnborough, Hants., England). In: Institute of Electrical and Electronics Engineers, Photovoltaic Specialists Conference, 8th, Seattle, Wash., August 4-6, 1970, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1970, p. 319-325. 8 refs.

Review of progress in the development of a reliable, low-cost lightweight deployable array of silicon solar cells. The power-to-weight ratio of the 1-g design, which has some novel features, is 53 W/kg (24 W/lb). A series of 125-micron cells with wrap-around contacts is in pilot production following type approval. The cover slips are of a new cheap, radiation-resistant type. (Author)

A71-16100 * **A concept for generating commercial electrical power from sunlight.** William R. Cherry (NASA, Goddard Space Flight Center, Greenbelt, Md.). In: Institute of Electrical and Electronics Engineers, Photovoltaic Specialists Conference, 8th, Seattle, Wash., August 4-6, 1970, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1970, p. 331-337. 7 refs.

This paper proposes a method for reducing the critical electrical peak power shortage in the U.S. without adding further to the atmospheric and surface water pollution. Also, very small amounts of surface area are required and it will reduce the consumption of our earth's rapidly diminishing mineral resources. Our most abundant and limitless natural resource, solar energy, can provide over 250,000 kw of electrical power per square mile (equivalent to the NYC Indian Point Nuclear Plant) using today's solar cell technology. It is proposed to float a 'solar rug' on a helium mattress, between 50,000 and 70,000 feet, above the major cities in the U.S., well out of the weather and its disturbances, to supplement the peak power demands during the daylight hours. Calculations show that a square mile mattress 100 feet thick can support 10,000 tons at 53,000 feet elevation, sufficient to provide for a manned power station. While several aspects of the idea will require some major engineering development, a large proportion of this has already been done on a smaller scale in the space program and could be directly applied to solving some of our most critical terrestrial problems. (Author)

A71-16102 **Increased output from silicon solar cells.** P. A. Iles (Globe-Union, Inc., El Monte, Calif.). In: Institute of Electrical and Electronics Engineers, Photovoltaic Specialists Conference, 8th, Seattle, Wash., August 4-6, 1970, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1970, p. 345-352.

Description of some advanced high-output silicon solar cells that have made it possible to raise the relatively long, fixed upper solar-cell output limit of 15.5 mW/sq cm to above 18 mW/sq cm. Their usefulness for space applications will depend on their performance at the expected radiation levels. In their favor is their wider range of design degrees of freedom. M.V.E.

A71-16103 **Silicon solar cell technology of the seventies.** R. Gereth, H. Fischer, E. Link, S. Mattes, and W. Pschunder (Telefunken AG, Heilbronn, West Germany). In: Institute of Electrical and Electronics Engineers, Photovoltaic Specialists Conference, 8th, Seattle, Wash., August 4-6, 1970, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1970, p. 353-359. 16 refs.

Demonstration that the performance of Si solar cells has been improved by incorporating new technologies. Passivated Ti(Pd)Ag contacts together with a p(+)-back contact guarantee a predictable

performance between -196 and +180 C. The cells survive storage at elevated temperatures or in humid atmosphere. A new wrap-around contact ensures maximum power output. A reactively evaporated TiO sub x film gives the best optical match between cell and cover glass. Gettered cells exhibit ultimate technological efficiency (e.g., 12% for a 300-micron, 10 ohm-cm, p-on-n cell) and a 20% increased power to weight ratio for 100-micron cells. (Author)

A71-16104 **A new look at silicon solar cell performance.** Martin Wolf (Pennsylvania, University, Philadelphia, Pa.). In: Institute of Electrical and Electronics Engineers, Photovoltaic Specialists Conference, 8th, Seattle, Wash., August 4-6, 1970, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1970, p. 360-371. 26 refs.

The loss mechanisms in present silicon solar cells have been reexamined and their impact on conversion efficiency in airmass zero and airmass one sunlight analyzed. Attention is focused on the process dependent losses which affect collection efficiency, voltage factor, and curve factor. The collection efficiency can be improved by 22% in the short wavelength region by reduction of surface recombination velocity and by increased minority carrier lifetime - combined with a drift field at the back contact in thin cells - in the long wavelength range. Voltage factor and curve factor yield 56% improvement by reduction of base region resistivity, while maintaining the minority carrier lifetime near present values. Accomplishment of these changes should yield conversion efficiency values near 20% in airmass zero sunlight. (Author)

A71-27432 * **Highlights of a brushless direct-drive solar array control system design.** L. J. Veillette (NASA, Goddard Space Flight Center, Space Power Technology Branch, Greenbelt, Md.). *(Institute of Electrical and Electronics Engineers, Power Conditioning Specialists Conference, Greenbelt, Md., Apr. 20, 21, 1970.) IEEE Transactions on Aerospace and Electronic Systems,* vol. AES-7, Mar. 1971, p. 324-328.

This paper summarizes a drive system design for controlling the position and rate of solar power arrays on orbiting spacecraft. There are no gears or sliding contact elements used anywhere in the system and only low-speed bearings are needed. Such mechanization is particularly well suited to solid lubrication techniques, and wear rates are very low, so that the drive system can operate directly in the space environment for long periods of time. Three major components were developed for implementation of this design concept. They are: (1) a brushless dc torque motor; (2) a rotary power transformer; and (3) an offset-tooth shaft position and rate sensor. These components are combined in a hybrid system configuration in which the signal processing and logic functions are performed by digital and linear integrated circuits. A root contour and describing function analysis, confirmed by experimentation, shows that several modes of limit cycle generation can occur in the vicinity of null. Compensation circuits are given that inhibit or suppress limit cycling and provide controlled electronic damping of the system. The system offers relatively high stiffness and can be operated at indefinitely low angular rates with minimum power consumption. (Author)

A71-28665 **Power without pollution.** Peter E. Glaser (Arthur D. Little, Inc., Cambridge, Mass.). *Journal of Microwave Power,* vol. 5, Dec. 1970, p. 211-222. 33 refs.

A concept for a satellite solar power station is described to meet future large scale electrical power requirements without burdening the environment or leading to natural resource exhaustion. Considerations are given to solar energy conversion, microwave generation and transmission, and conversion of microwave energy to electrical power on earth. The system considerations and the development tasks for a large satellite solar power station are reviewed and the potential technological needs are identified. (Author)

A71-28666 **Microwave power transmission from an orbiting solar power station.** G. Goubau (U.S. Army, Institute for Exploratory Research, Fort Monmouth, N.J.). *Journal of Microwave Power,* vol. 5, Dec. 1970, p. 223-231. 6 refs.

The paper considers the problem of microwave power transmission from an orbiting solar power station to the earth. In particular, questions such as the optimum frequency range, antenna dimensions and mechanical tolerances, phasing and directional control, and attainable transmission efficiencies are discussed. (Author)

A71-28668 **High power microwave generators of the crossed-field type.** William C. Brown (Raytheon Co., Waltham, Mass.). *(International Microwave Power Institute, Symposium, 5th, The Hague, Netherlands, Oct. 7-9, 1970.) Journal of Microwave Power,* vol. 5, Dec. 1970, p. 245-259. 8 refs.

The proposal to obtain electrical energy from the sun by means of an enormous solar cell array positioned in space at synchronous orbit altitude places a challenging requirement upon the means of converting this energy into microwave form so that it can be relayed to the earth's surface. Crossed-field device technology is consistent with the needs for high efficiency, long life, and for either modest or very high power levels in the dc to rf energy conversion process. A dc to rf energy conversion efficiency of 93% and an overall efficiency of 86% have been demonstrated in a high power magnetron. Continuous power over 400 kW at 3000 MHz and an efficiency of 76% have been obtained from the Amplitron, a crossed-field amplifier device. The development of a pure-metal, secondary emitter cathode provides long life capability. Newly developed permanent magnet material provides the high magnetic fields needed for high efficiency with low resulting weight. (Author)

A71-28669 **High power linear beam tube devices.** P. Guenard (Thomson - CSF, Orsay, Essonne, France). *Journal of Microwave Power,* vol. 5, Dec. 1970, p. 261-267. 7 refs.

As compared to high power tubes for satellite-borne communications transmitters, tubes for a space power station have no requirements on bandwidth and linearity characteristics. For this reason, the travelling wave tubes, which are interesting for communications because of their ability to transmit wide frequency bands, would very likely be discarded for power generation, because of their lower efficiency, which would require a rather complicated depressed collector. Among the various types of klystrons, the electrostatically focussed tube would bring the advantage of a lower weight, but this tube has to be improved to reach the efficiencies which have been demonstrated for magnetically focussed tubes. The discussion of a figure of merit in comparing various types of tubes for this particular application shows the importance, to reduce the overall weight, of operating the collector at as high a temperature as possible. This could be done with klystrons, where the heat dissipating electrode is well separated from the gun and the microwave structure. This high temperature operation of the heat radiators, together with a new technology based on an open structure and the extensive use of heat pipes should put the klystron in a good competitive position for the equipment of space power stations. (Author)

A71-28671 **The receiving antenna and microwave power rectification.** William C. Brown (Raytheon Co., Waltham, Mass.). *(International Microwave Power Institute, Symposium, 5th, The Hague, Netherlands, Oct. 7-9, 1970.) Journal of Microwave Power,* vol. 5, Dec. 1970, p. 279-292. 7 refs.

In a space power system the energy captured from the sun by means of a gigantic solar cell array is relayed to the earth by means of a microwave beam where the microwave energy is captured and converted into dc power. The capture and conversion processes can be jointly accomplished by a large nondirective aperture several square miles in area made from many small receiving apertures each terminated in an efficient solid-state rectifier. This kind of device,

called a 'rectenna,' has achieved a combined collection and rectification efficiency of over 50% in the laboratory. An overall efficiency of 85% to 90% should be possible with additional development effort. A possible future direction of the evolution of this device for the space power station application is reviewed. (Author)

A71-29702 **A new look at silicon solar cell performance.** M. Wolf (Pennsylvania, University, Philadelphia, Pa.). *Energy Conversion,* vol. 11, June 1971, p. 63-73. 26 refs.

The loss mechanisms in present silicon solar cells are reexamined and their impact on conversion efficiency in airmass zero and airmass one sunlight are analyzed. Special attention is given to the process-dependent losses which affect collection efficiency, voltage factor, and curve factor. The collection efficiency can be improved by 22% in the short wavelength region by reduction of surface recombination velocity and by increased minority carrier lifetime - combined with a drift field at the back contact in thin cells - in the long wavelength range. Voltage factor and curve factor yield 56% improvement by reduction of base region resistivity, while maintaining the minority carrier lifetime near present values. Accomplishment of these changes should yield conversion efficiency values near 20% in airmass zero sunlight. Z.W.

A71-31671 # **Calculation and cost optimization for some parameters of solar generator thermobatteries (K raschetu i optimizatsii po stoimosti nekotorykh parametrov termobatarei solnechnykh generatorov).** L. M. Drabkin (Tashkentskii Institut Inzhenerov Zheleznodorozhnogo Transporta, Tashkent, Uzbek SSR). *Geliotekhnika,* no. 1, 1971, p. 9-15. In Russian.

Discussion of production cost optimization for solar power plants by properly selecting the heat carrier temperature, the contact-packet thermal resistance, the thermophysical parameters of the materials, and the fabrication technology for component batteries. Expressions are given for a profitable combination of design features of a solar power plant. Diagrams are plotted for fabrication cost per 1 W thermoelectric power. V.Z.

A71-31672 # **Performance reliability calculation for a solar thermoelectic generator module (K voprosu rascheta nadezhnosti raboty modul'nogo solnechnogo termoelektrogeneratora).** Iu. N. Malevskii and A. I. Tsvetkov (Gosudarstvennyi Nauchno-Issledovatel'skii Energeticheskii Institut, Moscow, USSR). *Geliotekhnika,* no. 1, 1971, p. 16-20. 6 refs. In Russian.

Analysis of the overall reliability of a solar energy converter unit composed of thermoelectric modules, as a function of the reliability of individual photocells and component modules. Expressions are given to determine the reliability of various module circuit designs having the modules in series, parallel and combined connections. The usefulness of redundancy in these designs is noted. Suggestions are given concerning the selection of module circuit designs most suitable for given operational requirements. V.Z.

A71-42536 # **Efficiency of solar energy converters based on CdS-Cu(2 - x)S heterojunctions (Effektivnost' preobrazovatelei solnechnoi energii no osnove geteroperekhodov CdS-Cu/2 - x/S).** S. Iu. Pavelets and G. A. Fedorus (Akademiia Nauk SSSR, Institut Poluprovodnikov, Leningrad, USSR). *Geliotekhnika,* no. 3, 1971, p. 3-8. 13 refs. In Russian.

Calculation of the efficiency of these semiconductor junctions in solar energy converters under optimal conditions. The characteristics of the photoeffect in these materials are discussed. Approaches to the efficiency enhancement in these photoconverters are analyzed. The maximum possible efficiency of photocells of this type is estimated. V.Z.

A71-44390 # **Some properties of photoconverters based on compressed sintered tablets (CST) of CdS (Nekotorye svoistva fotopreobrazovatelei na osnove spressovannykh spechennykh tabletok /SST/ CdS).** A. I. Marchenko, G. A. Fedorus, and V. N. Zhukova. *Poluprovodnikovaia Tekhnika i Mikroelektronika,* no. 6, 1971, p. 101-107. 10 refs. In Russian.

Powdered CdS was compressed into tablets 0.5 to 1 mm thick, 10 and 2 mm in diameter. The tablets were sintered in argon, coated unilaterally with CuS by dipping in CuCl, and used as the material for photoelectric converters. A high sensitivity throughout the visible spectrum and a solar-to-electric energy conversion efficiency of 3.5% are established for the converters. The current-voltage and capacitance-voltage characteristics of the heterojunction of these converters are determined. A tunnel-recombination type of the junction is established. V.Z.

A72-11770 **Concept for a satellite solar power system.** P. E. Glaser (Arthur D. Little, Inc., Cambridge, Mass.). *Chem Tech,* Oct. 1971, p. 606-614. 35 refs.

Description of a concept for a satellite solar power station that involves collection of solar energy conversion to electrical power, and generation and transmission of microwaves. The microwave power, beamed from the satellite to an earth antenna, is converted into electrical power to be distributed through conventional power distribution networks. The technology required for such a satellite solar power station is explored, including conversion of solar energy to electrical power with photovoltaic solar cells, transmission of electrical power over superconducting lines to microwave generators, generation transmission and interception of microwaves, guidance and control of the satellite, and conversion of microwave power to dc power. Consideration is given to the payloads to be placed into orbit, orbit location, satellite station assembly methods, microwave beam interactions with the atmosphere, satellite and earth installation dimensions, and ultimately cost projections. A.B.K.

A72-15891 # **A proposed new concept for a solar-energy converter.** R. L. Bailey (Florida, University, Gainesville, Fla.). *American Society of Mechanical Engineers, Winter Annual Meeting, Washington, D.C., Nov. 28-Dec. 2, 1971, Paper 71-WA/Sol-1.* 5 p. 7 refs. Members, $1.00; nonmembers, $3.00. Research supported by the University of Florida.

The possibilities are explored to create high efficiency solar-electricity converters utilizing the wave-like properties of radiation interacting with absorber-converter elements. The concept is based on the feasibility of extending principles of power absorbing antennas and converters to the visible light range. The resulting proposed converter structure would have a rough surface texture and yield a dc output. It may have significant efficiency, cost, and fabricating advantages, particularly for large-scale terrestrial utilization of solar energy. The concept is called an Electromagnetic Wave Energy Converter. G.R.

A72-15892 * # **The generation of pollution-free electrical power from solar energy.** W. R. Cherry (NASA, Goddard Space Flight Center, Greenbelt, Md.). *American Society of Mechanical Engineers, Winter Annual Meeting, Washington, D.C., Nov. 28-Dec. 2, 1971, Paper 71-WA/Sol-2.* 5 p. 9 refs. Members, $1.00; nonmembers, $3.00.

Projections of the U.S. electrical power demands over the next 30 years indicate that the U.S. could be in grave danger from power shortages, undesirable effluence, and thermal pollution. An appraisal of nonconventional methods of producing electrical power is conducted, giving particular attention to the conversion of solar energy into commercial quantities of electrical power by solar cells. It is found that 1% of the land area of the 48 states could provide the total electrical power requirements of the U.S. in the year 1990. The ultimate method of generating vast quantities of electrical power would be from a series of synchronous satellites which beam microwave power back to earth to be used wherever needed. Present high manufacturing costs of solar cells could be substantially reduced by using massive automated techniques employing abundant low cost materials. G.R.

A72-15893 * # **Terrestrial adaptation of the thermal heliotrope.** J. W. Fairbanks (NASA, Goddard Space Flight Center, Space Power Technology Branch, Greenbelt, Md.) and F. H. Morse (Maryland, University, Silver Spring, Md.). *American Society of Mechanical Engineers, Winter Annual Meeting, Washington, D.C., Nov. 28-Dec. 2, 1971, Paper 71-WA/Sol-10.* 10 p. 9 refs. Members, $1.00; nonmembers, $3.00.

The principle of using bimetal helical coils to cause solar arrays to track the sun in space is presently under consideration for array orientation on several spacecraft. Adaptation of this thermal heliotrope to terrestrial applications introduces additional design considerations. The dominance of solar-radiation energy input to the helical coil over convective energy losses has to be ensured, and wind effects must be minimized. As long as the cost of solar cells remains high, orientation will always result in a significant cost saving for the converter. G.R.

A72-16909 # **Solar absorptance of a cylindrical solar cell array.** A. J. Gopin (Hughes Aircraft Co., El Segundo, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-57.* 8 p. Members, $1.50; nonmembers, $2.00.

Experiments were conducted to determine the change in the overall solar absorptance of a cylindrical solar array when the solar flux vector is inclined from the normal to the axis of rotation. The absorptances of two solar cell array samples of differing coverglass thicknesses were measured on a Gier-Dunkle integrating sphere at incidence angles of 20, 56, 77, and 83 deg from the normal. The analysis of the data indicates that the effective solar absorptance of a cylindrical solar cell array is within 5% of the near-normal value for the solar flux vector inclined as much as 65 deg from the normal. Beyond 65 deg, the solar absorptance decreases rapidly. T.M.

A72-17751 **Telesun, the solar cell of the future (Telesun, die Solarzelle der Zukunft).** H. Fischer and R. Gereth. *AEG-Telefunken, Technische Mitteilungen,* vol. 61, no. 6, 1971, p. 351, 352. In German.

Solar cells have recently been considerably improved. Single cells with a length of 6 cm and a width of 2 cm have been manufactured. These cells have noncorroding titanium (palladium) silver contacts. The cells are connected with each other by welding. Lossless wrap-around contacts, a titanium oxide antireflection layer, and improved photoelectric efficiency are characteristic features of the new 'telesun' cells. G.R.

A72-18625 # **Power without pollution.** P. E. Glaser (Arthur D. Little, Inc., Cambridge, Mass.). In: Space for mankind's benefit; Proceedings of the First International Space Congress, Huntsville, Ala., November 15-19, 1971. Preliminary Volume. Huntsville, Ala., Huntsville Association of Technical Societies, 1971, p. 40-1 to 40-16. 25 refs.

Methods of conversion of solar energy to power are discussed as a possible source of power without pollution. The topics include N/P silicon solar cells, solar power transmission techniques, guidance and control of solar cell systems, cooling equipment, and weight and cost projections for satellite solar power stations. V.Z.

A72-18627 # **Power and energy for posterity.** R. R. Barthelemy and R. F. Cooper (USAF, Wright-Patterson AFB, Ohio). In: Space for mankind's benefit; Proceedings of the First International Space Congress, Huntsville, Ala., November 15-19, 1971. Supplement. Huntsville, Ala., Huntsville Association of Technical Societies, 1971, p. 23-31.

Prospective applications of modern power and energy producing technology to the benefit of the general public are considered, covering pollution-free energy generation to meet the future requirements in power, heat and propulsion, and in ground, air and space transportation. Individual types of energy generation are analyzed in terms of their utility value and their potentials in the reduction of air, noise, thermal, water, and nuclear pollution. V.Z.

A72-24314 # **Calculation procedures and energetic characteristics for cooling systems with an atomizing-nozzle chamber and solar heaters (Metodika rascheta i energeticheskie pokazateli kholodil'nykh ustanovok s forsunochnoi kameroi i solnechnymi nagrevateliami).** A. Kakabaev and M. Golaev (Akademiia Nauk Turkmenskoi SSR, Fiziko-Tekhnicheskii Institut, Ashkhabad, Turkmen SSR). *Geliotekhnika,* no. 5, 1971, p. 49-56. In Russian.

Discussion of a cooling system based on vaporization of a solar-cell-preheated solution in a heated air flow drawn through a chamber with an atomizing injector. Expressions are derived for working solution recycling control and for the output characteristics of this cooling system. V.Z.

A72-24315 # **Selective surfaces and coatings in solar radiation engineering (Selektivnye poverkhnosti i pokrytia v geliotekhnike).** M. M. Koltun (Gosudarstvennyi Nauchno-Issledovatel'skii Institut Istochnikov Toka, USSR). *Geliotekhnika,* no. 5, 1971, p. 70-80. 48 refs. In Russian.

Review of the literature in this field, covering selective coatings for semiconductor photoconverters, for solar energy converters using white-black surfaces, and for cooling systems using solar energy. The achievements in this field are summarized as the construction of a theoretical basis for the development of selective surfaces for solar energy conversion, and the fabrication of selective coatings with nearly optimal optical properties for all types of solar energy conversion systems. V.Z.

A72-24316 # **Energy economics prognostication for the prospects of solar radiation utilization (Energoekonomicheskoe prognozirovanie perspektiv ispol'zovaniia solnechnoi radiatsii).** L. V. Gudkov, R. A. Zakhidov, and A. V. Sheklein (Gosudarstvennyi Nauchno-Issledovatel'skii Energeticheskii Institut, Moscow, USSR). *Geliotekhnika,* no. 5, 1971, p. 81-85. 5 refs. In Russian.

A theoretical basis is derived for forecasting the economic merits of various types of solar energy conversion systems. Formulas are given to evaluate the cost efficiency of systems using solar energy as compared to that of systems using other sources of energy. V.Z.

A72-28002 **State of the CNES solar cell research and development programme.** G. H. Coste (Centre National d'Etudes Spatiales, Brétigny-sur-Orge, Essonne, France). In: Solar cells; Proceedings of the International Colloquium, Toulouse, France, July 6-10, 1970. London and New York, Gordon and Breach Science Publishers, 1971, p. 11-20.

Review of French solar cell R&D accomplishments and future trends. Following a brief historical summary, French research programs are shown to have been devoted to the development of silicon cells, improvement of silicon cell performance under irradiation, and exploratory projects on thin film solar cells including cadmium telluride and cadmium sulfide cells, graded gap structures, and indium phosphide layers. Activities of the present and trends of the immediate future are characterized by a struggle between silicon photovoltaic cells and thin layer cells. It is obviously possible to improve still further the performance of silicon cells by increasing their efficiency and reliability and by reducing their weight and cost. Yet, continued efforts devoted to thin layer cells seem well worthwhile, since the risks inherent in several unknowns affecting service life are counterbalanced by promises of solar generators of substantially lower weight and costs. M.V.E.

A72-28003 **Solar cell development in the Federal Republic of Germany.** H. R. Lösch (Gesellschaft für Weltraumforschung mbH, Bad Godesberg, West Germany). In: Solar cells; Proceedings of the

International Colloquium, Toulouse, France, July 6-10, 1970. London and New York, Gordon and Breach Science Publishers, 1971, p. 21-33. 39 refs.

Brief survey of German solar cell development activities, and review of their results. Performed work includes improvements of silicon solar cells, development of polycrystalline solar cells, and studies of deployable structures for large solar generators. New interconnection techniques, module design features, and filter applications are to improve the performance of cells. Prototypes of various deployable panels have been built. One of them is made of glassfiber-reinforced polymers. A planned solar electric propulsion module is intended to test ion thrusters, deployable solar cell arrays, and power conditioning systems. A list of publications of the last two years on German solar cell development activities is presented. M.V.E.

A72-28005 **Review of advanced solar generator development.** K. K. Reinhartz (ESRO, European Space Research and Technology Centre, Noordwijk, Netherlands). In: Solar cells; Proceedings of the International Colloquium, Toulouse, France, July 6-10, 1970. London and New York, Gordon and Breach Science Publishers, 1971, p. 51-63; Discussion, p. 64. 19 refs.

Advanced American and European solar generator technology developments are reviewed. U.S. work has been concentrated on roll-up solar cell arrays with flexible solar panels. Weight predictions range from 2.0 kg/sq m to 1.7 kg/sq m for arrays of 1.5 and 2.5 kW power. Different approaches to the stowage and deployment of flexible solar panels have been investigated by several U.S. companies. Since 1968, ESRO has also supported work related to the development of a roll-up array. In the first phase of this project, completed in June 1970, the main emphasis was on developing a flexible solar cell panel that could withstand the extreme temperature cycling requirements without cell performance degradation. In the present phase, the main components of the stowage and deployment system are studied. M.V.E.

A72-28008 **Study of the Cu/x/S barrier layer in Cu-Cd-S solar cells.** A. E. V. Aerschodt and K. K. Reinhartz (ESRO, European Space Research and Technology Centre, Noordwijk, Netherlands). In: Solar cells; Proceedings of the International Colloquium, Toulouse, France, July 6-10, 1970. London and New York, Gordon and Breach Science Publishers, 1971, p. 95-109. 14 refs.

Discussion of the effect upon solar cell efficiency of the electrochemical potential of the cell during plating and of the composition of the plating solution. An important procedure in the manufacture of thin film Cu-Cd-S solar cells is the formation of a thin Cu(x)S surface layer on a CdS base layer by chemiplating in CuCl plating solutions. Electrochemical measurements on Cu(x)S electrodes in aqueous copper ion solutions have been performed recently, and the above-mentioned effect is discussed in the light of these measurements. M.V.E.

A72-28016 **Technological improvements on CdS solar cells.** G. Coste (Centre National d'Etudes Spatiales, Brétigny-sur-Orge, Essonne, France), J. Fremy, and D. T. Nguyen (Société Anonyme des Télécommunications, Paris, France). In: Solar cells; Proceedings of the International Colloquium, Toulouse, France, July 6-10, 1970. London and New York, Gordon and Breach Science Publishers, 1971, p. 187-199. 9 refs.

Review of recent progress in CdS thin film solar cell development. The influence of the cadmium sulfide evaporation (substrate temperature and deposition rate) on cell efficiencies is determined. The copper sulfide layer formed by the chemical process plays an active part in photon-electron conversion. The short circuit-current mainly depends on etching and Cu2S thickness. Gridding and encapsulation technologies are optimized (homogeneity of temperature and pressure). On the basis of this study, a standard process for highly efficient solar cell fabrication is developed. Preliminary results on stability characterization are given. (Author)

A72-28021 **The use of thin film solar cells in the radiovoltaic generators.** R. Bomal, A. Manin, and K. Steinschaden (Commissariat à l'Energie Atomique, Centre d'Etudes Nucléaires de Saclay, Gif-sur-Yvette, Essonne, France). In: Solar cells; Proceedings of the International Colloquium, Toulouse, France, July 6-10, 1970. London and New York, Gordon and Breach Science Publishers, 1971, p. 257-272. 11 refs.

The performance of thin-film solar cells depends on the characteristics of the radioisotopes and the band-gap of the semiconductor. Tritium sources offer many advantages for radiovoltaic conversion. A one microwatt generator with a design lifetime of 10 years is described. Generators for various applications are considered, giving attention to watches, cardiac pacemakers, and microelectronic power supplies. G.R.

A72-28026 **Increased output from silicon solar cells.** P. A. Iles (Globe-Union, Inc., El Monte, Calif.). In: Solar cells; Proceedings of the International Colloquium, Toulouse, France, July 6-10, 1970. London and New York, Gordon and Breach Science Publishers, 1971, p. 333-347.

Description of the development of advanced high-output silicon solar cells. Compared with the current solar cells having an upper limit to output power density of 15-16 milliwatts per sq cm, the new cells have an upper limit of 18 milliwatts per sq cm. The cells are compatible with all combinations of large area, thin cells, wrap-around contact structures, and with the various metal combinations used. Their probable impact upon the state-of-the-art is discussed. O.H.

A72-28029 **Some innovations in silicon solar cell technology.** H. Fischer, R. Gereth, E. Link, S. Mattes, and W. Pschunder (Telefunken AG, Heilbronn, West Germany). In: Solar cells; Proceedings of the International Colloquium, Toulouse, France, July 6-10, 1970. London and New York, Gordon and Breach Science Publishers, 1971, p. 375-388. 8 refs.

Advanced solar cell generators must operate in a predictable mode over a wide range of environmental conditions. Solar cell performance at low temperature and low illumination levels has been investigated. It could be demonstrated that anomalies in solar cell current-voltage characteristic are caused by different fabrication processes of the back contact. Instead of an ohmic contact a Schottky contact is achieved, whose nonlinear impedance characterizes the cell performance. It was shown that only if a p(+)-layer is produced underneath the back contact maximum electrical performance of a solar cell can be achieved down to -196 C operation temperature and low illumination levels down to 5 mW/sq cm. Distorted current-voltage characteristics of solar cells could be attributed to an inversion layer and the formation of leakage channels along the edges of a cell. (Author)

A72-28034 **Design considerations on 'advanced' rigid or semi-rigid solar panels.** J. Ciabrini and R. Eloerg (Engins MATRA, S.A., Vélizy-Villacoublay, Yvelines, France). In: Solar cells; Proceedings of the International Colloquium, Toulouse, France, July 6-10, 1970. London and New York, Gordon and Breach Science Publishers, 1971, p. 457-464.

Description of the progress to date in the study of rigid and semirigid solar panel structures, designed for future geostationary satellites, and capable of supplying power of the order of 1 and 4 kW. Several basic structural concepts are compared from the point of view of performance, feasibility, and costs. High-performance materials and advanced technology are considered. The most promising options presently available are emphasized. O.H.

A72-30225 # **Solar elements based on heterojunctions of p-type GaAs/1-x/P/x/ and n-type GaAs (Solnechnye elementy na osnove geteroperekhodov p-GaAs/1 - x/P/x/-n-GaAs).** A. G. Cheban, V. V. Negreskul, P. T. Oush, L. V. Gorchak, G. I. Ungurianu, and V. G. Smirnov. *Radiotekhnika,* vol. 27, Mar. 1972, p. 30-33. 10 refs. In Russian.

Measured dark current-voltage characteristics, light current-voltage characteristics under load, and spectral response curves are given for photosensitive elements prepared by liquid epitaxial growth of p-type GaAs/1-x/P/x/ on an n-type GaAs substrate. Due to the absence of a conditioning surface layer, 30% of the radiation incident on the working surface is reflected, yielding an efficiency of 6 to 7%. Recommendations are given for improvement in this area. T.M.

A72-32131 * # **Silicon solar cell efficiency - Practice and promise.** H. W. Brandhorst, Jr. (NASA, Lewis Research Center, Cleveland, Ohio). *Institute of Electrical and Electronics Engineers, Photovoltaic Specialists Conference, 9th, Silver Spring, Md., May 2-5, 1972, Paper.* 7 p. 23 refs.

The maximum efficiency of silicon solar cells is calculated and yields a value near 18%. Additionally, the performance of these high efficiency cells in a synchronous orbit radiation field is calculated and indicates that these cells would be superior to present silicon cells at all times. The performance of conventional cells is analyzed and several areas in which performance gains may be achieved are discussed. These areas include improvements in diffused region profile, in reduction of excess forward currents in cells made from low resistivity material and in the theory for describing complex solar cell structures. (Author)

A72-34264 **Theoretical and practical fill factors in solar cells.** J. Lindmayer (Communications Satellite Corp., Washington, D.C.). *COMSAT Technical Review,* vol. 2, Spring 1972, p. 105-121. 5 refs.

The fill factor determines the fraction of power available to a load with respect to the open-circuit-voltage short-circuit-current product. This paper calculates the theoretically expected values and compares them with measured values. In silicon p-n junction energy converters, fill factor values over 0.82 are expected according to diffusion theory, but actual solar cells exhibit a fill factor of about 0.72. Recombination in the space charge region is found to be the reason for the reduced fill factor in practical cells. The mechanism discussed also has implications with respect to the open-circuit voltage. (Author)

A72-35509 # **Thermodynamic analysis and parameter optimization of a solar thermoelectric power plant with heat removal by radiation (Termodinamicheskii analiz i optimizatsiia parametrov solnechnoi termoelektricheskoi energoustanovki s otvodom tepla izlucheniem).** L. M. Drabkin (Tashkentskii Institut Inzhenerov Zheleznodorozhnogo Transporta, Tashkent, Uzbek SSR). *Geliotekhnika,* no. 3, 1972, p. 15-23. 8 refs. In Russian.

A72-35516 # **A universal power characteristic of a high-temperature solar heat source (Universal'naia energeticheskaia kharakteristika solnechnogo vysokotemperaturnogo istochnika tepla).** V. A. Grilikhes and V. M. Matveev. *Geliotekhnika,* no. 3, 1972, p. 68-71. 5 refs. In Russian.

A72-36075 **Large-scale concentration and conversion of solar energy.** A. F. Hildebrandt, G. M. Haas, W. R. Jenkins (Houston, University, Houston, Tex.), and J. P. Colaco. *EOS,* vol. 53, July 1972, p. 684-692. 31 refs.

Description of a proposed solar energy power plant which first concentrates the solar energy and then applies a thermodynamic conversion cycle. A concentrator is proposed which consists of a large number of individual movable mirrors which reflect the solar energy onto a single collector atop a large tower. The concentrated energy can then be converted to electrical power either by means of a steam cycle, using liquid metals for heat transfer down the tower, or by a closed-cycle MHD generator; in this case preference is given to a closed-cycle MHD process employing an inert gas of helium with cesium seeding. The intermittent nature of the solar energy can be overcome by electrolyzing water into hydrogen and oxygen gas and storing the energy either in the form of compressed hydrogen and oxygen gas or as cryogenic liquids. Energy storage in the form of hydrogen is especially attractive, since it offers the possibility of a pollution-free fuel for the internal combustion engine. A.B.K.

A72-36681 **Parallel operation of the solar generator and battery on the Symphonie satellite (Parallelbetrieb von Solargenerator und Batterie im Satelliten Symphonie).** A. Schreger. *AEG-Telefunken, Technische Mitteilungen,* vol. 62, no. 3, 1972, p. 125-128. In German.

A72-37642 * # **Solar array cost reduction.** D. T. Bernatowicz (NASA, Lewis Research Center, Cleveland, Ohio). *U.S. Army, Power Sources Symposium, 25th, Atlantic City, N.J., May 23-25, 1972, Paper.* 10 p.

The costs regarding solar power systems are considered, giving attention to the total system cost index for the power system as a function of solar array area, and the recurring cost per square foot for the solar array versus the total area flight arrays built for each project. It is found that the costs decrease as production volume increases. Design standardization together with improvements in solar cell and array technology show promise of reducing costs. A long range program has been started to improve substantially the efficiency of silicon cells. Efficiencies approaching 20% are theoretically possible. One obstacle to cost reduction is that the volume of production required to satisfy the space program is not enough to justify a high degree of mechanization or automation. G.R.

A72-37675 **Remarks concerning solar furnaces in space.** M. Hoëz and M. Foëx (CNRS, Laboratoire des Ultra-Réfractaires, Odeillo, Pyrénées-Orientales, France). *Solar Energy,* vol. 13, July 1972, p. 417-420. 6 refs.

Discussion of some of the opportunities offered by high-temperature, high-vacuum, solar-furnace processing of materials in space or on the moon. The high-temperature treatment (with or without fusion) of refractory metals (tungsten, tantalum, iridium) could eliminate certain of their gaseous or volatile impurities and render malleable products that at present cannot be prepared in other than very fragile form. Such processing in space vacuum could also open new avenues of research in physics and chemistry. Some of the problems posed by solar-furnace space experiments are reviewed. M.V.E.

A72-37780 **Contribution to silicon solar cell technology.** R. Gereth, H. Fischer, E. Link, S. Mattes, and W. Pschunder (Telefunken AG, Heilbronn, West Germany). *Energy Conversion,* vol. 12, Sept. 1972, p. 103-107. 22 refs.

Description of certain recent innovations in solar cell technology aimed at satisfying the high electrical power to weight ratio and resistance to extreme environmental conditions demanded by some of the space missions presently contemplated or in preparation. The innovations described include: (1) passivated, corrosion-resistant, and weldable Ti(Pd)Ag contacts which can be exposed to high temperatures and temperature cycles; (2) wrap-around contacts without degradation of maximum electrical power; (3) titanium-oxide antireflex coating resulting in a better optical match between cover glass and solar cell; and (4) controlled lifetime of minority carriers in the base region, yielding the ultimate technological conversion efficiency. M.V.E.

A72-43187 # **Methods for the quality control of the reflecting surfaces of solar energy condensers /Survey/ (Metody kontrolia kachestva otrazhaiushchikh poverkhnostei kontsentratorov solnechnoi energii /Obzor/).** V. A. Grilikhes. *Geliotekhnika*, no. 4, 1972, p. 3-15. 30 refs. In Russian.

A72-43194 # **Calculation of the solar radiation incident on an inclined ribbed surface (Raschet solnechnoi radiatsii, padaiushchei na naklonno-rebristuiu poverkhnost').** Iu. N. Iakubov, G. Ia. Umarov, and K. B. Baibutaev (Bukharskii Pedagogicheskii Institut, Bukhara, Uzbek SSR). *Geliotekhnika*, no. 4, 1972, p. 60-63. In Russian.

Development of a method of calculating the direct solar radiation incident on a southward facing solar energy receiver with an inclined ribbed configuration. The proposed method is based on a study of the change in the azimuth of the chosen receiver with a change in the angles of inclination of two surfaces. A.B.K.

A72-45126 # **Investigation of the possibility of using radiant solar energy for welding and soldering of materials (Issledovanie vozmozhnosti ispol'zovaniia luchistoi energii solntsa dlia svarki i paiki materialov).** I. N. Frantsevich, V. S. Dverniakov, V. V. Pasichnyi, N. A. Shiganov, and Iu. I. Korunov (Akademiia Nauk Ukrainskoi SSR, Kiev, Ukrainian SSR). *International Astronautical Federation, International Astronautical Congress, 23rd, Vienna, Austria, Oct. 8-15, 1972, Paper.* 10 p. In Russian.

Description of solar-furnace equipment and test results in a simulation study of the feasibility of using solar energy for welding, soldering, and heat treatment of metals in space. Solar energy was concentrated by a parabolic reflector (2-m diameter) providing a flux density of about 20,000 cal/sq cm per min in a focal point 8 mm in diameter at normal solar irradiation. The flux was focused on samples held in a vacuum chamber with a quartz window. Energy losses in the quartz window and in the atmosphere are evaluated, and test data are given for welds in tubular samples of steel and titanium alloy. Overall results demonstrate the feasibility of solar welding both in space and on the earth surface. T.M.

A73-10132 **High-efficiency Ga/1-x/Al/x/As-GaAs solar cells.** J. M. Woodall and H. J. Hovel (IBM Thomas J. Watson Research Center, Yorktown Heights, N.Y.). *Applied Physics Letters*, vol. 21, Oct. 15, 1972, p. 379-381. 8 refs.

It is shown that heterojunction cells consisting of Ga(1-x) Al(x)As on a GaAs substrate possess highly improved efficiencies as compared to conventional homojunction (Si and GaAs) cells. The improved efficiency is attributed to the reduction of both series-resistance and surface-recombination losses resulting from the presence of the heavily doped Ga(1-x)Al(x)As layer. V.P.

A73-12048 **Secondary ionisation and its possible bearing on the performance of a solar cell.** S. Deb (Jadavpur University, Calcutta, India) and H. Saha (Jadavpur University, Calcutta; Kalyani, University, Nadia, West Bengal, India). *Solid-State Electronics*, vol. 15, Dec. 1972, p. 1389-1391. 7 refs.

A73-14203 **Photovoltaic Specialists Conference, 9th, Silver Spring, Md., May 2-4, 1972, Record.** Conference sponsored by the Institute of Electrical and Electronics Engineers. New York, Institute of Electrical and Electronics Engineers, Inc., 1972. 400 p. Members, $15.; nonmembers, $20.

Topics discussed include new developments in silicon solar cells, Cu2S-CdS and other compound solar cells, solar cell module technology, space applications of solar cells, space environmental effects on solar cell operation, and terrestrial applications of solar cell arrays. In particular, studies are made of the solar cells used for the Helios sun probe, the flight of a sun-tracking flexible rolled-up solar array, and the solar array system for the Skylab orbital workshop. Also, the results of studies of the role of lithium additives in annealing radiation-induced defects in silicon solar cells are presented.

Individual items are announced in this issue. A.B.K.

A73-14204 **Evolution of silicon solar cell design.** P. A. Iles (Globe Union, Inc., El Monte, Calif.). In: Photovoltaic Specialists Conference, 9th, Silver Spring, Md., May 2-4, 1972, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1972, p. 1-5.

This paper surveys the wide range of processing variables which can be used to fabricate silicon solar cells. It describes the more complex cell designs which have evolved. Present cells while simple in appearance, are seen to be fairly sophisticated. (Author)

A73-14207 **Advances in graded gap solar cell research.** G. Cohen-Solal, L. Svob, Y. Marfaing (CNRS, Laboratoire de Physique des Solides, Meudon, Hauts-de-Seine, France), E. Janik (Instytut Elektrotechniki, Warsaw, Poland), and E. Castro (Facultad de Ingenieria, Buenos Aires, Argentina). In: Photovoltaic Specialists Conference, 9th, Silver Spring, Md., May 2-4, 1972, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1972, p. 28-36. Research supported by the Centre National d'Etudes Spatiales.

An experimental investigation regarding two graded band gap systems is reported, including (ZnHg)Te and (CdHg)Te solar cells. Attention is given to the preparation of semiconductor layers, current-voltage characteristics, and spectral response curves. It is found that it is possible to prepare graded band gap p-n junctions with good electrical and photoelectrical properties. Best results were obtained with Cd-Hg-Te solid solutions. G.R.

A73-14209 * **The 'Silicon Solar Cell Design Handbook.'** M. Wolf (Pennsylvania, University, Philadelphia, Pa.). In: Photovoltaic Specialists Conference, 9th, Silver Spring, Md., May 2-4, 1972, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1972, p. 53-60. 9 refs. Grant No. NGL-39-010-001.

The design activities are divided in the handbook into three parts, which are concerned with the light-generated current, the open-circuit voltage, and the fill factor. Each of these parts is further divided into sections, which take into account the individual regions of the device. The basis of the design data for light-generated current and of the design data related to the current-voltage characteristic is discussed together with sample design curves. G.R.

A73-14210 **Laser activation of solar cells.** C. E. Backus (California, University, Los Alamos, N. Mex.; Arizona State University, Tempe, Ariz.). In: Photovoltaic Specialists Conference, 9th, Silver Spring, Md., May 2-4, 1972, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1972, p. 61-65. 5 refs. AEC-sponsored research.

A preliminary investigation has been conducted on the feasibility of using photovoltaic cells to convert laser energy into electrical energy. The tests were made with readily available solar cells and lasers. When using the He-Ne laser, the efficiencies of the silicon cells were improved by about 50% compared to operation in sunlight. The improvement in efficiency could have conceivably been increased to about 90% if an optimum wavelength laser were used. Efficiencies of GaAs cells also were improved about 50% but could perhaps have been increased to about 130% with an appropriate laser. (Author)

A73-14212 **An improved silicon solar cell - The violet cell.** J. Lindmayer and J. Allison (COMSAT Laboratories, Clarksburg, Md.). In: Photovoltaic Specialists Conference, 9th, Silver Spring,

Md., May 2-4, 1972, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1972, p. 83, 84.

In the violet cell the spectral response has been extended to wavelengths as short as 0.3 micrometers. A significant improvement of the solar cell current was obtained as a result of this extension. The conversion efficiency has been further improved by an increased fill factor. The overall improvement in the conversion efficiency obtained is about 30% relative to state-of-the-art cells for space applications. G.R.

A73-14213 **Vertical multijunction solar cell.** P. Stella and A. Gover (Textron, Inc., Sylmar, Calif.). In: Photovoltaic Specialists Conference, 9th, Silver Spring, Md., May 2-4, 1972, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1972, p. 85, 86. Contract No. F33615-72-C-1310.

Minority carrier lifetime and the diffusion constant were determined as a function of impurity concentration in a double-junction multifunction vertical solar cell. The efficiency of a solar cell of this design was also deduced from power output calculations and current and voltage calculation at maximum power. A diagram is given to show the results. V.Z.

A73-14216 **High efficiency Cu2S-CdS-solar cells with improved thermal stability.** K. Bogus and S. Mattes (Telefunken AG, Heilbronn, West Germany). In: Photovoltaic Specialists Conference, 9th, Silver Spring, Md., May 2-4, 1972, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1972, p. 106-110. 5 refs.

The effect of thin metal films on Cu2S-CdS solar cells has been investigated. By deposition of a thin copper layer it is possible to increase the short circuit current and the efficiency to optimum values. A similar behavior is observed after a glow discharge treatment in hydrogen. Besides improving the solar cell efficiency these procedures have a balancing effect on final performance of cells with different fabrication parameters. (Author)

A73-14220 **New results on the development of a thin-film p-CdTe-n-CdS heterojunction solar cell.** D. Bonnet and H. Rabenhorst (Battelle-Institut, Frankfurt am Main, West Germany). In: Photovoltaic Specialists Conference, 9th, Silver Spring, Md., May 2-4, 1972, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1972, p. 129-132. 9 refs. Research supported by the Bundesministerium für Bildung und Wissenschaft.

The objective of this work is the development of a thin-film graded-gap CdTe-CdS p-n heterojunction solar cell. As a first step an abrupt heterojunction between p-CdTe and n-CdS has been studied. The CdTe layer is produced by a high temperature gas transport method, the CdS is deposited by the conventional method of high-vacuum evaporation. The cells exhibit an efficiency between 5 and 6% under illumination with simulated solar light of 50 mW/sq cm at room temperature. (Author)

A73-14222 **Investigations of the inhomogeneity of polycrystalline Cu/x/S-CdS solar cells.** G. H. Hewig and F. Pfisterer (Stuttgart, Universität, Stuttgart, West Germany). In: Photovoltaic Specialists Conference, 9th, Silver Spring, Md., May 2-4, 1972, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1972, p. 138-141. 9 refs. Gesellschaft für Weltraumforschung Contract No. RV-I-1-TO-3/71-B.

The local distribution of the surface potential and the photovoltaic efficiency of a Cu(x)S-CdS solar cell have been studied by scanning techniques. A scanning electron beam and a scanning light beam yield information on the surface potential and on the local photovoltaic efficiency. Degraded cells exhibit large inhomogeneous regions, whereas a Cu(x)S-CdS solar cell with improved stability of AEG-Telefunken Heilbronn exhibits a homogeneous photovoltaic effect over the total cell area. (Author)

A73-14226 **Solar cell optical design considerations.** R. W. Opjorden (Hughes Aircraft Co., El Segundo, Calif.). In: Photovoltaic Specialists Conference, 9th, Silver Spring, Md., May 2-4, 1972, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1972, p. 164-173.

For the past several years, the Power Systems Department at Hughes has been engaged in the study, both theoretical and experimental, of the effect of the solar cell's complex optical properties on solar panel electrical performance. In other words, the solar cell is recognized as an optical instrument, not simply as an electronic black box. Cell optical constraints on panel design are important for missions that involve high and low temperatures and/or nonnormal incident illumination. Under such conditions, solar cells and cover slides purchased under normal incidence, 25 C specifications shift in performance, yielding unnecessary performance penalties. Consideration and optimization of optical properties yields performance gains and cost savings in panel design. (Author)

A73-14237 **Status report on RAE advanced solar array development.** F. C. Treble (Royal Aircraft Establishment, Farnborough, Hants., England). In: Photovoltaic Specialists Conference, 9th, Silver Spring, Md., May 2-4, 1972, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1972, p. 254-262. 11 refs.

Recent progress in RAE advanced lightweight solar array technology is reviewed. Solar cell performance has been improved. Panel assemblies embodying the RAE cementless mounting technique have successfully withstood prolonged deep thermal cycling and other environmental tests. Some are currently being flown experimentally on the Prospero technological satellite. A stowed array has survived severe vibration with negligible damage. A solution has been found to the problem of protecting the backs of the cells from low energy protons. Useful experience has been gained in all aspects of the manufacture, handling and testing of flexible folding arrays. Design qualification tests have begun on a 280 W prototype. The advantages and disadvantages of the RAE design in relation to the alternative roll-up type are discussed. (Author)

A73-14242 **Lithium solar cell technology.** P. A. Iles (Globe-Union, Inc., El Monte, Calif.). In: Photovoltaic Specialists Conference, 9th, Silver Spring, Md., May 2-4, 1972, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1972, p. 296-302. 9 refs.

The current status of lithium-doped solar cells is considered with particular attention to their fabrication criteria and mission design factors. The effects of various lithium distributions on the current-voltage characteristics of solar cells are discussed. Lithium-doped solar cells are characterized as ones having the highest output ever obtained in solar cells in sunlight both in space and at the earth's surface. V.Z.

A73-14250 **Cost goals for silicon solar arrays for large scale terrestrial applications.** M. Wolf (Pennsylvania, University, Philadelphia, Pa.). In: Photovoltaic Specialists Conference, 9th, Silver Spring, Md., May 2-4, 1972, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1972, p. 342-350. 8 refs.

A73-14251 * **Feasibility of low cost silicon solar cells.** C. G. Currin, W. A. Smith (Dow Corning Corp., Hemlock, Mich.), K. S. Ling (Globe-Union, Inc., El Monte, Calif.), E. L. Ralph (Textron, Inc., Sylmar, Calif.), and R. J. Stirn (California Institute of

Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Photovoltaic Specialists Conference, 9th, Silver Spring, Md., May 2-4, 1972, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1972, p. 363-369. 7 refs.

Future costs of silicon solar cells are projected on the basis of more than a thousand-fold increase in volume. If no major application of new manufacturing technology is made, the cost remains excessive for any large scale energy system. However, the development of a multiple-ribbon crystal growth process could permit a 300-fold reduction in cell costs to about $375/kW of cell output. (Author)

A73-14253 **Solar arrays for terrestrial applications and sounding balloons.** Y. Salles (Radiotechnique-Compelec, Suresnes, Hauts-de-Seine, France). In: Photovoltaic Specialists Conference, 9th, Silver Spring, Md., May 2-4, 1972, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1972, p. 382-385.

Review of the technical evolution which has led to the present type of solar land generators. The results of the operation of solar energy plants in various parts of the world are cited, noting some technological problems caused by the environment and the solutions proposed. An evaluation is made of the future prospects for solar generators, and, in particular, an estimate is made of the cost of generating energy by means of solar cell arrays. In addition, three types of solar generators for powering the gondolas attached to sounding balloons are described. A.B.K.

A73-15801 # **The feasibility of a satellite solar power station.** P. E. Glaser (Arthur D. Little, Inc., Cambridge, Mass.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Nov. 26-30, 1972, Paper 72-WA/Sol-6.* 5 p. 6 refs. Members, $1.00; nonmembers, $3.00.

The concept of a satellite solar power station which would have the capability to convert solar energy to microwaves which are beamed to a receiving antenna to produce power on Earth is presented. The state-of-the-art of the technology required to achieve efficient solar energy conversion, microwave power generation, transmission and rectification is reviewed. Approaches to structural design, flight control and Earth-to-Orbit transportation are presented. (Author)

A73-15802 # **Thermal performance of a linear solar collector.** A. B. Meinel (Arizona, University, Tucson, Ariz.) and M. P. Meinel (Helio Associates, Inc., Tucson, Ariz.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Nov. 26-30, 1972, Paper 72-WA/Sol-7.* 4 p. Members, $1.00; nonmembers, $3.00. NSF Grant No. G1-30022.

A series of graphs presents the relationships between the optical system factors and the resulting system efficiency of a linear solar collector. The range of operating temperature is 200 to 600 C for a wide range of surface selectivities and optical flux concentrations. (Author)

A73-16816 **Schottky barrier diodes for solar energy conversion.** W. A. Anderson and A. E. Delahoy (Rutgers University, New Brunswick, N.J.). *IEEE, Proceedings,* vol. 60, Nov. 1972, p. 1457, 1458. 5 refs. NSF Grant No. GI-32726.

Several Schottky barrier solar cells were fabricated by evaporation and sputtering of Al ohmic contacts and Cr or AuCr alloy barrier metals on 0.5-10.0 ohm-cm p-type silicon. Potential efficiencies of 4.8 to 12 percent were observed which would be realized with improved fill factors. Computer studies of the optical problem indicate an output power increase by a factor of four through the use of reduced barrier metal thickness (from 275 to 100 A) and alloy barrier metals to more effectively transmit solar energy to the Schottky junction. (Author)

A73-18027 **Space resources to benefit the earth.** P. E. Glaser (Arthur D. Little, Inc., Cambridge, Mass.). *(New York Academy of Sciences, Conference on Planetology and Space Mission Planning, 3rd, New York, N.Y., Oct. 28-30, 1970.) New York Academy of Sciences, Annals,* vol. 187, Jan. 25, 1972, p. 406-419. 43 refs.

Discussion of the potential benefits that may be derived from future space missions, with special attention to space as a source of energy. The possibilities held forth by a satellite solar power station concept are reviewed in terms of the solar-energy conversion technology status, microwave generation and beam transmission, conversion of microwave power to DC power, and weight and cost projections. M.V.E.

A73-18028 **Electrical and isotope power from space for terrestrial use.** T. B. Taylor (International Research and Technology Corp., Washington, D.C.). *(New York Academy of Sciences, Conference on planetology and Space Mission Planning, 3rd, New York, N.Y., Oct. 28-30, 1970.) New York Academy of Sciences, Annals,* vol. 187, Jan. 25, 1972, p. 420-426.

The concept of an orbital facility for converting solar energy to stored fission energy for use in terrestrial power plants is reviewed in terms of overall system parameters and economics. It is suggested that the concept is worth studying in considerably greater detail. M.V.E.

A73-18976 **Solar generator technology on the Symphonie satellite.** M. Berniere (Société Anonyme de Télécommunications, Paris, France). In: French space technology. Volume 2. Paris, Information Propagande Françaises, Editeur; Centre National d'Etudes Spatiales, 1972, p. 231-240. In English and French.

Consideration of the problems involved in the development of solar generators for a communication satellite stabilized about three axes in synchronous orbit. The solution chosen for the Symphonie satellite is one in which the solar generator is a fixed 24-hour orbit generator interlocked with the satellite. Problems in reducing the thermal constraints in such a design are considered, as well as problems in achieving proper interconnection between solar cells and the problem of choosing the proper welding method. The results of a five-year program of simulated space qualification testing are cited. A.B.K.

A73-22438 **A system for the evaluation of solar cell samples.** H. L. Skolnik (Harris Semiconductor, Melbourne, Fla.). *Solar Energy,* vol. 14, Dec. 1972, p. 43-54.

The system described is a solar cell test vehicle intended primarily for education and research applications. Because of the many advantages to be derived from testing cells under real sky conditions, the sun is utilized as the system's energy source. The system design provides for the measurement of open-circuit voltage, short-circuit current, internal impedance, and output power, each as a function of incident energy. A means for the accurate angular positioning of the solar cell provides for the determination of cosine response. A specially-designed, direct reading pyrheliometer featuring fast response provides normal incident radiation data, allowing for the accurate determination of conversion efficiency. Spectral response measurements are made by comparing the output of the cell under test, both with and without accessory bandpass filters. The temperatures of both the solar cell and the ambient air can be monitored for future data correlation. A clock drive provides for the continuous alignment of the sample holder with the sun, allowing for measurements over extended periods of time. Samples as large as 4.3 in. in diameter can be accommodated. (Author)

A73-22439 **Developments in solar cell generators.** E. G. Suppa and J. Heinicke (Messerschmitt-Bölkow-Blohm GmbH, Ottobrunn, West Germany). *Solar Energy,* vol. 14, Dec. 1972, p. 55-65. 8 refs.

The European satellite projects of today and the near future, to be applied for measuring tasks demanding highest accuracy or used in missions of extended lifetime, have stimulated the development of new solar cell module concepts. Low outgassing rates, magnetic and electric cleanliness (as achieved by conductive coatings), high thermal cycling capability and extended lifetime (by improved solar cell interconnection techniques), high temperature capability for sun missions or healing radiation damage, integral cover slips for reducing weight, and high module flexibility for use on deployable large-area panels mark the trends in module development. Based on the work for the German AEROS satellite project and the work on roll-up structures, the module concepts are described and test results are given. Power data on the solar cells are reported and compared with the results of JPL balloon flights and the measurements in the DIAL project. Advanced developments are discussed. (Author)

A73-22440 **Passive solar array orientation devices for terrestrial application.** J. W. Fairbanks (NASA, Goddard Space Flight Center, Space Power Technology Branch, Greenbelt, Md.) and F. H. Morse (Maryland, University, College Park, Md.). *Solar Energy*, vol. 14, Dec. 1972, p. 67-79. 9 refs.

A passive solar array orientation device, called a thermal heliotrope, is described, and several terrestrial applications are illustrated. The thermal heliotrope consists of a bimetallic helical coil that serves as the motor element, producing torque and angular displacement. A control mechanism in the form of one or more shades completes the basic device. In comparison with electromechanical tracking systems, the thermal heliotrope is electrically passive, has relatively few parts, and is low cost. After describing the principle of operation and several models built for space applications, the design considerations for several terrestrial thermal heliotrope units are presented. It is suggested that the use of the thermal heliotrope for solar array orientation could significantly reduce array cost, thereby increasing the competitive economic posture of solar arrays for terrestrial applications. The thermal heliotrope modified for terrestrial use is readily adaptable to orient solar energy concentrators, such as furnaces and stills. (Author)

A73-22782 **Configuration survey of lightweight solar array power systems for future missions.** D. R. Lott (Lockheed Missiles and Space, Inc., Electrical Power Systems Dept., Sunnyvale, Calif.). In: Intersociety Energy Conversion Engineering Conference, 7th, San Diego, Calif., September 25-29, 1972, Proceedings. Washington, D.C., American Chemical Society, 1972, p. 430-437. 11 refs.

A73-22785 * **A dynamic solar-electric power/thermal control system for spacecraft.** B. K. Davis (NASA, Marshall Space Flight Center, Huntsville, Ala.). In: Intersociety Energy Conversion Engineering Conference, 7th, San Diego, Calif., September 25-29, 1972, Proceedings. Washington, D.C., American Chemical Society, 1972, p. 457-465. 8 refs.

This paper describes a solar-electric power and active thermal control system for spacecraft with solar energy to electricity conversion efficiency of more than 20%. Briefly, the solar heat energy is absorbed by flat plate collectors yielding above 70% of the energy incident for conversion by an organic condensing cycle. The cycle operates between 132 and 6.67 deg C. The working fluid is F-114 which flows through a solar collector to absorb heat, then through a regenerator and into the radiator where it is condensed to a liquid. The cold liquid flows through two paths, one providing regenerator cooling, the other providing spacecraft thermal control. The system total weight is about 170kg/kW of electrical energy produced. The dynamic system replaces batteries by a thermal capacitor for eclipse period energy storage, thereby eliminating many battery charging and control problems as well as improving efficiency and weight characteristics of the system. (Author)

A73-22791 **Satellite solar power station - An option for power generation.** P. E. Glaser (Arthur D. Little, Inc., Cambridge, Mass.). In: Intersociety Energy Conversion Engineering Conference, 7th, San Diego, Calif., September 25-29, 1972, Proceedings. Washington, D.C., American Chemical Society, 1972, p. 507-511. 7 refs.

The principle on which a satellite solar power station (SSPS) is based is the conversion of solar energy into electricity. This electricity would be fed to microwave generators arranged to form an antenna which, in turn, could direct a beam to a receiving station on the earth where the microwave energy could be efficiently and safely converted back to electricity to meet baseload power needs. The status of the technology required to meet the objectives of an SSPS is discussed. F.R.L.

A73-22792 **The Solar Collector Thermal Power System - Its potential and development status.** E. T. Mahefkey, Jr. (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio). In: Intersociety Energy Conversion Engineering Conference, 7th, San Diego, Calif., September 25-29, 1972, Proceedings. Washington, D.C., American Chemical Society, 1972, p. 512-521. 28 refs.

The evolution of the Vuilleumier cryogenic cooler as the foremost cryogenic refrigerator candidate for several military and scientific spacecraft applications has prompted interest in a Solar Collector Thermal Power System (SCTPS) to provide the necessary thermal energy input. The Air Force Aero Propulsion Laboratory has sponsored both in-house and contractual study efforts to define the performance potential of (SCTPS). The results of these studies, and corroborative experimental results on system component performance characteristics are described. The performance (efficiency weight, volume, deployed area), costs, and integration ease of the SCTPS are compared to that of a conventional solar cell array-battery and a modified SNAP-10A nuclear reactor system. These comparisons show the SCTPS offers greater than a 50% weight reduction over the competitors, and the deployed area of the SCTPS is only 20% that of a solar array-battery system. Efficiency of the SCTPS is predicted to be 50% for the solar to thermal conversion and heat transport/thermal energy storage processes. (Author)

A73-22814 **A systems engineering overview of the satellite power station.** J. Mockovciak, Jr. (Grumman Aerospace Corp., Bethpage, N.Y.). In: Intersociety Energy Conversion Engineering Conference, 7th, San Diego, Calif., September 25-29, 1972, Proceedings. Washington, D.C., American Chemical Society, 1972, p. 712-719. 11 refs.

The utilization of solar energy as a prime power source has been a long-held dream of mankind. With increasing attention focusing on the energy crisis, many new schemes are being proposed involving both space-based and ground-based applications of solar energy. Among these is a proposed concept of a satellite solar power station (SSPS), which collects energy from the sun and transmits it to earth via microwave for conversion to electrical power. Recent systems engineering studies, assessing the technical and economic aspects of the SSPS are presented. These studies indicate that the basic concept is technically feasible, and that it should be examined and compared to other potential energy systems. (Author)

A73-23601 **Satellite power stations - A new source of energy.** W. C. Brown (Raytheon Co., Lexington, Mass.). *IEEE Spectrum*, vol. 10, Mar. 1973, p. 38-47. 30 refs.

It has been suggested by Glaser (1968) that large arrays of solar photovoltaic cells should be placed into space in near-equatorial synchronous orbit where the sun would shine upon them nearly 100 per cent of the time. The dc power obtained from the photovoltaic arrays would then be converted into microwave power, beamed to the surface of the earth, and there converted back into dc power. This concept has become known as the Satellite Solar Power Station

(SSPS). The system configuration and characteristics of the SSPS are discussed together with the solar photovoltaic cell array, details of the microwave power transmission system, and side effects of the SSPS system. G.R.

A73-24554 **The potential of power from space.** P. E. Glaser (Arthur D. Little, Inc., Cambridge, Mass.). In: EASCON '72; Electronics and Aerospace Systems Convention, Washington, D.C., October 16-18, 1972, Record. (A73-24551 10-34) New York, Institute of Electrical and Electronics Engineers, Inc., 1972, p. 34-41. 18 refs.

The concept of a satellite solar power station which would have the capability to convert solar energy to microwaves that are beamed to a receiving antenna on earth is presented. Approaches to structural design, flight control, and earth-to-orbit transportation are presented. Criteria for technology assessment and standards for cost comparisons are discussed. It is concluded that the option this concept offers for large-scale use of solar energy could meet a significant portion of future energy demands. M.V.E.

A73-26001 * # **Concept for a high voltage solar array with integral power conditioning.** P. Wiener (California Institute of Technology, Jet Propulsion Laboratory, Power Systems Group, Pasadena, Calif.) and R. Rasmussen (General Electric Co., Space Div., Valley Forge, Pa.). In: Energy 70; Proceedings of the Fifth Intersociety Energy Conversion Engineering Conference, Las Vegas, Nev., September 21-25, 1970. Volume 1. Hinsdale, Ill., American Nuclear Society, 1972, p. 10-19 to 10-30. Contract No. NAS3-8997.

Description of a general case solution that synthesizes a high voltage solar array system from a switchable building block concept which makes possible system optimization for specific load requirements. A specific optimized solution is demonstrated, with performance estimates relating array area, weight, and power. Significant technology problems peculiar to a high-voltage switchable solar array design are discussed, along with special requirements anticipated during a hardware development effort. M.V.E.

A73-29590 **Historical development of solar cells.** M. Wolf (Pennsylvania, University, Philadelphia, Pa.). In: Power Sources Symposium, 25th, Atlantic City, N.J., May 23-25, 1972, Proceedings. Red Bank, N.J., PSC Publications Committee, 1972, p. 120-124.

The historical development of solar cell technology is briefly reviewed, with emphasis on recent developments and on data which are not generally available. The general conclusion is that the silicon solar cell is firmly established as the mainstay of space power and that it will continue to fulfill this role. Effort will be spent on further improvement of its efficiency, with 20% being held as the goal which might be reached within the present decade. The cadmium sulfide thin film cell is a strong contender for the terrestrial solar cell market, but it will have to be established that the reliability and operating life of this cell are adequate. T.M.

A73-29591 **Principles of photovoltaic solar energy conversion.** J. J. Loferski (Brown University, Providence, R.I.). In: Power Sources Symposium, 25th, Atlantic City, N.J., May 23-25, 1972, Proceedings. Red Bank, N.J., PSC Publications Committee, 1972, p. 124-127.

The current level of theoretical knowledge on the photovoltaic effect in semiconductors is surveyed by examining processes involving generation of positive and negative carrier pairs in excess of thermal equilibrium concentrations, charge separation in the photovoltaic cell, and migration of carriers to the charge separation site. Performance data indicate that no semiconductor has reached its predicted maximum efficiency in solar cell applications. In the case of silicon, this failure to reach predicted maximum efficiency is attributed to inadequate quality of the semiconductor material comprising the cell. T.M.

A73-29592 * **Solar array cost reductions.** D. T. Bernatowicz (NASA, Lewis Research Center, Cleveland, Ohio). In: Power Sources Symposium, 25th, Atlantic City, N.J., May 23-25, 1972, Proceedings. Red Bank, N.J., PSC Publications Committee, 1972, p. 128-130.

There is great interest in reducing the cost of solar arrays, which will continue to be the prime power source for unmanned spacecraft for some time. The cost of solar power systems over the last decade, and means by which cost reductions may be achieved in the future are discussed. It is shown that the total system cost index is a function of solar array area, and that cost decreases as production of solar arrays goes up. This effect can be exploited more than has been done in the past by making common building blocks from which a variety of arrays can be assembled. F.R.L.

A73-29593 * **Large area silicon solar array development.** J. V. Goldsmith (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Power Sources Symposium, 25th, Atlantic City, N.J., May 23-25, 1972, Proceedings. Red Bank, N.J., PSC Publications Committee, 1972, p. 130-133.

Solar array technology has made significant improvements during the past five years in terms of the design and application of multikilowatt systems and in improvements of the specific power output capabilities of the arrays. The progress in array performance has been primarily due to array design. Experience in building, testing, and flying flexible arrays is giving confidence that they can be safely integrated into many spacecraft designs without deleterious coupling with the spacecraft control system. F.R.L.

A73-29594 * **Research plans for solar power in space.** E. M. Cohn (NASA, Washington, D.C.). In: Power Sources Symposium, 25th, Atlantic City, N.J., May 23-25, 1972, Proceedings. Red Bank, N.J., PSC Publications Committee, 1972, p. 139-141.

The developments in space solar power technology are reviewed, with the emphasis on solar power output improvement as the goal of further efforts. It is contended that the biggest pay-off should be expected not from cost cutting in solar cell fabrication but from versatile improvement of solar cell designs to a feasible maximum. V.Z.

A73-29595 **Solar energy conversion development relative to Department of Defense space power requirements.** J. F. Wise (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio). In: Power Sources Symposium, 25th, Atlantic City, N.J., May 23-25, 1972, Proceedings. Red Bank, N.J., PSC Publications Committee, 1972, p. 141-145. 9 refs.

A73-29596 * **Advanced spacecraft fuel cell systems.** L. H. Thaller (NASA, Lewis Research Center, Cleveland, Ohio). In: Power Sources Symposium, 25th, Atlantic City, N.J., May 23-25, 1972, Proceedings. Red Bank, N.J., PSC Publications Committee, 1972, p. 152-155.

An evolutionary advanced technology program is described which is aimed at meeting the requirements of the next generation of fuel cell systems as well as providing technology fallout to ongoing mission oriented programs. The specific goals of the system selected for development are for 10,000 hr of operation with refurbishment, 20 lb/kW at a sustained power of 7 kW, and 21 kW peaking capability for durations of two hours. The system is designed to operate on low pressure propulsion grade hydrogen and oxygen. F.R.L.

A73-29597 **Megawatt fuel cells for aerospace applications.** D. R. Warnock (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio). In: Power Sources Symposium, 25th, Atlantic City, N.J., May 23-25, 1972, Proceedings. Red Bank, N.J., PSC Publications Committee, 1972, p. 155-158.

Description of a high power density fuel cell stack concept with an aqueous potassium hydroxide electrolyte contained in a capillary matrix of asbestos and potassium titanate. A porous sintered plate in partial contact with a hydrogen electrode forms a hydrogen flow field and serves as an additional container for the electrolyte. The high power density of the cells largely due to the low ohmic polarization capability of the thin matrix. Preliminary tradeoff studies on a very large reference system indicate that the fuel cell system should have a slightly higher fixed weight and a slightly lower full-load reactant consumption rate than alternate power systems. V.Z.

A73-30475 **Investigations on CdTe thin film solar cells.** E. W. Justi, J. Seredynski (Braunschweig, Technische Universität, Braunschweig, West Germany), and G. Schneider. *Energy Conversion,* vol. 13, Apr. 1973, p. 53-56. 24 refs.

CdTe films were fabricated by direct synthesis of the vacuum evaporated elements Cd and Te following Heyerdahl and Harvey (1965). Both source temperatures and the substrate temperature must be controlled. The CdTe films were evaporated in a high vacuum coating unit. The influences of the CdTe film production process, of substrate layers and surface treatment, and of metallic collector grids are studied. After some hours storage in an exsiccator at room temperature the solar cells showed an increase of efficiency. F.R.L.

A73-32193 * # **The utilization of solar energy to help meet our nation's energy needs.** R. L. Thomas (NASA, Lewis Research Center, Cleveland, Ohio). *National Professional Societies of New Mexico, Energy Crisis Symposium, Albuquerque, N. Mex., May 3, 4, 1973, Paper.* 26 p. 19 refs.

A73-32718 **The feasibility of a satellite solar power station.** P. E. Glaser (Arthur D. Little, Inc., Cambridge, Mass.). In: NEREM 72; Northeast Electronics Research and Engineering Meeting, Boston, Mass., October 30-November 3, 1972, Record. Part 1. (A73-32717 16-09) Newton, Mass., Institute of Electrical and Electronics Engineers, Inc., 1972, p. 30-33.

Discussion of the technological, economic, and social considerations affecting the development of a satellite solar power station employing two extensive, symmetrically arranged solar cell arrays to produce electricity by photovoltaic conversion in synchronous orbit. The electricity from the solar cells is fed to microwave generators arranged to form an antenna located between the two arrays. The antenna directs the microwave beam to a receiving antenna on earth where the microwave energy is efficiently and safely converted back to electricity. Attention is given to expected developments in solar cell weight reduction, efficiencies of power conversion at each step of the process, satellite structural considerations, transportation tasks, economic merits of the project, and social implications. T.M.

A73-34283 # **Analysis of the parameters of solar-heat power sources with energy storage units (Analiz parametrov solnechnykh teplovykh energoustanovok s akkumuliatorami energii).** V. M. Matveev and V. A. Grilikhes. *Geliotekhnika,* no. 2, 1973, p. 15-20. 5 refs. In Russian.

Analysis of the influence of the energy storage system on the parameters of a space power source providing electricity by conversion of solar heat. It is required that the electric power output should remain constant throughout the dark and light portions of periodic solar illumination. A universal ratio is derived which makes it possible to estimate the optimal (with respect to minimum weight) temperature gradient over the light-dark cycle. Comparison is made between systems employing storage of thermal energy prior to conversion into electric power and systems employing storage of converted electric power by means of electrochemical storage batteries. T.M.

A73-35312 * **Some major terrestrial applications of solar energy.** W. R. Cherry (NASA, Goddard Space Flight Center, Greenbelt, Md.). In: Institute of Electrical and Electronics Engineers, International Convention and Exposition, New York, N.Y., March 26-30, 1973, Technical Papers. New York, Institute of Electrical and Electronics Engineers, Inc., 1973, p. 6/3-1 to 6/3-8. 10 refs.

A73-35313 **Solar power via satellite.** P. E. Glaser (Arthur D. Little, Inc., Cambridge, Mass.). In: Institute of Electrical and Electronics Engineers, International Convention and Exposition, New York, N.Y., March 26-30, 1973, Technical Papers. New York, Institute of Electrical and Electronics Engineers, Inc., 1973, p. 6/4-1 to 6/4-10. 24 refs.

There is justification for a reexamination of the potential of solar energy because among the different sources of energy, whether they be nonrenewable, such as fossil or nuclear fuels, or continuous, such as tidal or geothermal, none has a greater potential or represents, at least in mankind's terms, a more constant and inexhaustible energy source. The most favorable conditions for solar energy conversion are out in space in an orbit around the sun. The development of an economic earth-to-orbit transportation system based on the space shuttle opens up the option to carry out solar energy conversion in a satellite solar power station (SSPS) in synchronous orbit, with only the final conversion step taking place on the earth. Solar power via satellites could provide an economically viable and socially acceptable option to meet future world energy requirements. F.R.L.

A73-36331 # **Solar power.** E. R. G. Eckert (Minnesota, University, Minneapolis, Minn.). *American Institute of Aeronautics and Astronautics, Thermophysics Conference, 8th, Palm Springs, Calif., July 16-18, 1973, Paper 73-710.* 7 p. 10 refs. Members, $1.50; nonmembers, $2.00.

Discussion of the conversion of solar energy into thermal, chemical or electric energy. A crucial element in any scheme is shown to be the design of the solar collector. The conditions imposed by the specific application and the possibilities to obtain high collection efficiencies are investigated. Recent thin film technology developments are pointed out that have provided means for improvement of the absorber and the glass envelope of the collector. The storage of energy is also discussed. M.V.E.

A73-37969 # **Thermal control materials and technology in the 1970's.** J. E. Gilligan and G. A. Zerlaut (IIT Research Institute, Chicago, Ill.). *SAE, ASME, AIAA, ASMA, and AIChE, Intersociety Conference on Environmental Systems, San Diego, Calif., July 16-19, 1973, ASME Paper 73-ENAs-7.* 4 p. 13 refs. Members, $1.00; nonmembers, $3.00.

Recent activities in the research and development of stable spacecraft thermal controls materials and systems are reviewed, and projections are made for the expected achievements in this and other fields. In addition to the need to solve a synergistic reaction between zinc orthotitanate and certain siloxane vehicles, an additional requirement - that such systems be noncontaminating and noncontaminable - has added an important, and difficult dimension to the development of these coatings/surfaces. In the paper the R & D of an ultrastable, low alpha sub s/epsilon paint consisting of zinc orthotitanate and a modified commercial silicone is described. Some of the applications and materials requirements for solar energy utilization are discussed. The special requirements of electroconductive surfaces for reproduction and other uses are also briefly reviewed in light of applicable space thermophysics technology. (Author)

A73-38404 # **Feasibility of large-scale orbital solar/thermal power generation.** J. T. Patha and G. R. Woodcock (Boeing Co., Seattle, Wash.). In: Intersociety Energy Conversion Engineering Conference, 8th, Philadelphia, Pa., August 13-16, 1973, Proceedings. (A73-38386 19-03) New York, American Institute of Aeronautics and Astronautics, Inc., 1973, p. 312-319. 21 refs.

Discussion of a thermal conversion concept which is potentially feasible with today's solar concentrator technology and component efficiencies, if the low earth orbit transportation cost is approximately \$60/lb. The system is also potentially feasible with space shuttle transportation cost of approximately \$160/lb and 1980 component efficiencies if the solar concentrator can be constructed at approximately 0.03 lb/sq ft. The above conclusions are based on a projected competitive busbar value of electrical energy of 2 to 3 cents per kilowatt-hour. Projections indicate that launch systems technology can be expected ultimately to attain transportation costs as low as \$10/lb for low earth orbit missions. This value contributes \$25 per kilowatt of system capital cost. (Author)

A73-38408 * # **Development of a lightweight body-mounted solar cell array with a high power to weight ratio.** H. Somberg (Textron, Inc., Spectrolab Div., Sylmar, Calif.). In: Intersociety Energy Conversion Engineering Conference, 8th, Philadelphia, Pa., August 13-16, 1973, Proceedings. New York, American Institute of Aeronautics and Astronautics, Inc., 1973, p. 338-340. 7 refs. Research supported by Textron, Inc. and NASA.

Three lightweight solar cell arrays have been fabricated with a high power-to-weight ratio. These arrays incorporate resistance welded interconnections, improved antireflection coating on the solar cell and lightweight substrates. Two of the substrates were constructed of magnesium with different structural geometry, while the third substrate was conventional aluminum honeycomb. All arrays utilized thin solar cells having a titanium-palladium-silver contact system and an antireflection coating of titanium oxide. The cells were welded with silver plated molybdenum interconnections. The two arrays having magnesium substrates exhibited a power/weight of 70.4 W/kg (32 W/lb.) and 81 W/kg (36.8 W/lb.), while the conventional array demonstrated a power/weight of 45.2 W/kg (20.6 W/lb.). (Author)

A73-38409 # **An analysis of linear focused collectors for solar power.** R. B. Pope and W. P. Schimmel, Jr. (Sandia Laboratories, Albuquerque, N. Mex.). In: Intersociety Energy Conversion Engineering Conference, 8th, Philadelphia, Pa., August 13-16, 1973, Proceedings. New York, American Institute of Aeronautics and Astronautics, Inc., 1973, p. 353-359. 6 refs. AEC-supported research.

The use of linear focused collectors to collect solar energy in a high-quality (high-temperature) state is analytically studied. The effects of variations in concentration, absorptance, and emittance of the receiver, silvering of the envelope, and system geometry are considered. Convective and radiative transport between the receiver and envelope and from the envelope to the environment are modeled. Radiative exchange processes are modeled with an approximate two-wavelength band model. Calculated results are presented for varying values of specular solar input, linear aperture, concentration, absorptance, emittance, collection temperatures, for both silvered and unsilvered envelopes, and for both evacuated and unevacuated cavities. The study indicates that collector extraction efficiencies of 40 to 60% can be reasonably expected. (Author)

A73-38473 * **A solar engine using the thermal expansion of metals.** R. Beam and J. Jedlicka (NASA, Ames Research Center, Structural Dynamics Branch, Moffett Field, Calif.). *Solar Energy,* vol. 15, July 1973, p. 133-142. 5 refs.

A thermal engine which uses solid metal as the single-phase working substance to convert solar energy into small amounts of mechanical energy is described. Test data are given for an engine whose working substance was annealed 304-type steel welded into a thin-walled tube that was mounted in a bearing at each end (making it free to rotate about its axis) with a flywheel mass at its midpoint. When heated on its upper surface, the tube rotates producing steady power. The theory of the engine is outlined. V.P.

A73-39247 # **Solar power via satellite.** P. E. Glaser (Arthur D. Little, Inc., Cambridge, Mass.). *Astronautics and Aeronautics,* vol. 11, Aug. 1973, p. 60-68. 29 refs.

The satellite solar power station (SSPS) concept is described and shown to represent a major challenge to engineering and an unparalleled opportunity to apply space technology for the benefit of mankind. Its feasibility is contingent upon no fundamental breakthroughs. Whether it is worth being realized is shown to depend upon criteria of comparative cost, resource conservation, or environmental enhancement that may vary in the future as technology developments provide new energy production alternatives. It is felt that the necessary steps to protect the SSPS option should be taken in the meantime. M.V.E.

N68-12252*# Radio Corp. of America, Lancaster, Pa.
SOLAR THERMOELECTRIC GENERATOR DESIGN AND PANEL DEVELOPMENT PROGRAM
V. Raag, R. E. Berlin, and L. H. Gnau 20 Dec. 1967 122 p refs
(Contract NAS3-10600)
(NASA-CR-72340; RCA-647DR-1220) CFSTI: HC \$3.00/MF \$0.65 CSCL 10B

A silicon–germanium solar thermoelectric generator has been designed for operation at a distance of 0.25 AU from the sun. The generator delivers 150 watts of electrical power at a nominal load voltage of 28 volts; produces 36.4 watts per square foot of generator area; and weighs 3.23 pounds per square foot. The design and analysis of both thermoelectric and mechanical performances of this generator are considered in detail. Engineering layout drawings of the generator and its components are also presented. Author

N68-14185* Electro-Optical Systems, Inc., Pasadena, Calif.
PLANETARY SOLAR ARRAY DEVELOPMENT Quarterly Report
R. Wizenick 6 Jan. 1968 73 p Prepared for JPL
(Contracts NAS7-100; JPL-952035)
(NASA-CR-91730; EOS-7254-Q-2) CFSTI: \$3.00 CSCL 10A

Conceptual designs of photovoltaic solar arrays capable of producing 200 watts of raw electrical power on the Martian surface at solar noon are described. The following four concepts are evaluated: (1) deployable fixed array; (2) two axis, two panel array mounted from two opposing sides of the spacecraft with one common horizontal boom; (3) two axis, one panel array mounted on a single vertical boom together with the antenna; and (4) two axis two panel array mounted on a single vertical boom together with the antenna. Conceptual drawings of the candidate arrays are included. Solar circuit design, substrate design, and materials studies which provided a common basis for the concepts chosen for detail design studies are also examined. S.C.W.

N68-15766* Thermo Electron Engineering Corp., Waltham, Mass.
SIX-CONVERTER SOLAR THERMIONIC GENERATOR (JG-4) Quarterly Progress Report, 1 Jul.–15 Dec. 1967
P. K. Shefsiek, T. Athanis, and L. Lazaridis 15 Dec. 1967 57 p ref Prepared for JPL
(Contracts NAS7-100; JPL-951770)
(NASA-CR-92586; TE-4073-70-68; QPR-2) CFSTI: \$3.00 CSCL 10A

This work involves the design and fabrication of a Six-Converter Solar Thermionic Generator designated JG-4. During this reporting period the complete design was finalized, six converters were

abricated and tested, and all generator components were fabricated. ılso, the components for six other converters have been fabricated ınd processed. Author

N68-16074* Thermo Electron Engineering Corp., Waltham, Mass.
:OLAR THERMIONIC GENERATOR DEVELOPMENT Quarterly Report, 1 Sep.–30 Nov. 1967
ʼec. 1967 45 p Prepared for JPL
Contracts NAS7-100; JPL-951263)
NASA-CR-92520; TE-4055-83-68; QR-8) CFSTI: $3.00 CSCL 10A

Progress is reported in the development of a solar thermionic enerator. Areas discussed include (1) testing of converter T-207 using the S-type of filament as the electron bombardment ource, (2) fabrication of converter T-208, and (3) selection of a multiconverter generator configuration and calculation of its electrical performance for earth test and cislunar operation. Detailed test esults are shown in both graphical and tabular form. C.T.C.

N68-16695*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
ESIGN AND PERFORMANCE OF TWO VACUUM CHAMBERS AND SOLAR SIMULATORS FOR SOLAR-CELL RESEARCH
dolph C. Spagnuolo Washington Feb. 1968 18 p refs
NASA-TM-X-1503) CFSTI: HC$3.00/MF$0.65 CSCL 14B

A facility containing a 5-foot- (1.52-m-) and a 2-foot- (0.61-m-) liameter space-environmental chamber with two solar-radiation imulators and support equipment is described. The facility is lesigned for testing solar cells, thermoelectric and thermionic levices, and related components at vacuum levels in the 10^{-8}- to 0^{-9}-torr (10^{-6}- to 10^{-7}-N/m^2) range. The pumping systems ınd liquid-nitrogen-cooled shrouds are described. Information oncerning a test apparatus and a solar-cell installation method is ılso included. Author

N68-16882*# Radio Corp. of America, Princeton, N. J. Astro Electronics Div.
REVIEW AND EVALUATION OF PAST SOLAR CELL DEVELOPMENT EFFORTS Semiannual Report, Jun. 1–Nov. 0, 1967
. A. Crossley, G. T. Noel, and M. Wolf Dec. 1967 225 p efs
Contract NASw-1427)
NASA-CR-92679) CFSTI: HC$3.00/MF$0.65 CSCL 10A

During this period, the literature search and abstraction have been continued to fill gaps in the literature previously obtained, ınd to keep up with new publications. The coverage of this search ı now all but complete, and such gaps as are known to exist are letailed, and the efforts made to cover these are described. A bibliography lists those papers and reports which have been read nd abstracted during the reporting period. The main body of this eport is a historical review of the scientific work performed on hotovoltaic effects, and the development done on energy conversion levices using this effect, covering the period from 1940 to the resent time. Author

N68-17795 Pennsylvania Univ., Philadelphia.
OLAR COLLECTION LIMITATIONS FOR DYNAMIC CONVERTERS
George L. Schrenk *In* AGARD Combust. and Propulsion 1967 25–46 refs

A mathematical model for analysis of actual solar collectors has been developed. This model allows one to calculate the energy lux on any arbitrarily shaped focal surface from any arbitrarily shaped collector surface without making numerical approximations. Provisions are included for treating random surface errors on the eflector surface, orientation errors of any size, and vignetting of eflected light by a cavity opening. Typical results from this model are presented to show the effects of surface and orientation errors. This model has recently been used to investigate the interface between the collector and the heat receiver—the cavity opening. The directional assumption ordinarily made for this interface is that this opening can be treated as if it were a plane surface that emitted radiation according to Lambert's law (i.e., the cosine law). Results are presented that clearly show that this assumption is in substantial error for both perfect and imperfect collectors. Detailed analytical work has been performed on cylindrical heat receivers coupled with typical collectors. An "open cavity" Fredholm integral equation approach and the valid directional distribution have been utilized. The effects of the absorptivity and emissivity of the walls of the heat receiver have been investigated; reradiation losses and system performance have been calculated. The results presented differ significantly from the usual engineering estimates used in the design of solar power systems. Author

N68-17804 Centre National de la Recherche Scientifique, Paris (France).
LIMITATIONS OF SOLAR COLLECTORS FOR CONVERTERS [LIMITATIONS DES COLLECTEURS SOLAIRES POUR CONVERTISSEURS]
F. Trombe and E. Le Grives *In* AGARD Combust. and Propulsion 1967 p 279–314 refs Prepared jointly with Office Natl. d'Etudes et de Rech. Aerospatiales, Paris

Research on solar energy collectors and receivers for space applications. Review of various concentrator concepts and definition of receiver configurations leading to most promising performances. Analysis of main factors affecting efficiency (geometrical perfection, optical qualities, structural rigidity, response to meteorite impacts, etc.), and receiver efficiency (absorption characteristics, surface radiation...) Author

N68-18466# European Space Technology Center, Noordwijk (Netherlands).
SATELLITE POWER-CONDITIONING AND CONTROL: A SUMMARY OF DESIGN POSSIBILITIES
A. W. Preukschat Paris ESRO Oct. 1967 21 p
(ESRO-TM-54(ESTEC)) CFSTI: HC$3.00/MF$0.65

This paper deals with the power conditioning and control system of a solar cell array–battery power supply for satellites. Following a functional description, the general requirements and features of possible subsystems are discussed. Author (ESRO)

N68-18998*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
ANALYSIS OF THE MAXIMUM PERFORMANCE OF A PARABOLOIDAL SOLAR COLLECTION SYSTEM FOR SPACE POWER
Gabriel N. Kaykaty Washington Mar. 1968 19 p refs
(NASA-TN-D-4415) CFSTI: HC$3.00/MF$0.65 CSCL 10B

An analytical study was performed to investigate the effects and interactions of the concentrator surface errors and rim angle, collection system orientation error, and cavity receiver operating temperature on the maximum thermal efficiency of a paraboloid collection system operating in the vicinity of the earth. The ranges investigated were: standard deviation of surface error (0 to 18 min), orientation error (0 to 30 min), receiver temperature (2000° to 4000°R or 1110° to 2200°K), and concentrator rim angle (45 to 60 deg). Results indicate that the surface error, orientation error, and receiver operating temperature each decidedly affect the collection efficiency and that these effects are interdependent. It is shown that surface and orientation error became increasingly important with increasing receiver operating temperature. A variation in rim angle, on the other hand, produces only a slight variation in collection efficiency and does not materially modify the effects of the other three parameters. This information can be applied to the more comprehensive design optimization of a solar power system with regard to such factors as weight, size, and manufacturing simplicity. Author

N68-19128*# National Aeronautics and Space Administration, Washington, D. C.
ELECTRIC POWER GENERATION IN SPACE
Dec. 1967 20 p
(NASA Facts-NF-38) GPO: HC $0.20; CFSTI: MF $0.65 CSCL 10B

This educational facts pamphlet presents a comprehensive account of present and future electric power sources for space application. Covered are requirements and constraints of electric power generation in space, solar energy conversion, construction and functioning of solar cells, rechargeable batteries, fuel cells, thermoelectric and thermionic power plants and converters, the Brayton and Rankine cycles, and several Systems for Nuclear Auxiliary Power (SNAP) concepts. K.W.

N68-21879*# General Electric Co., Philadelphia, Pa. Missile and Space Div.
FEASIBILITY STUDY OF A 30 WATTS PER POUND ROLL UP SOLAR ARRAY Quarterly Technical Report, 1 Jan.–31 Mar. 1968
N. F. Shepard, K. F. Merten, and F. A. Blake 15 Apr. 1968 138 p refs Prepared for JPL
(Contracts NAS7-100; JPL-951970)
(NASA-CR-94243; Doc.-68SD4246; QTR-3) CFSTI: HC $3.00/MF $0.65 CSCL 10A

Activities for establishing the feasibility of a 30 watts per pound roll-up solar array are reported. Included are the complete definition of a model to demonstrate the deployability of the selected flight array configuration, thermal cycling tests of a 5-cell by 5-cell module, and factors affecting the array blanket edge curling phenomenon. Author

N68-22010# Bolkow Entwicklungen K. G., Munich (West Germany).
DEVELOPMENT OF ADVANCED SOLAR CELL MODULUS TECHNOLOGY FOR USE BY SOLAR PROBES AND LARGE AREA SOLAR CELL ARRAYS [ENTWICKLUNG VON FORTSCHRITTLICHEN SOLARZELLEN MODULTECHNOLOGIEN UNTER BERUECKSICHTIGUNG VON ANWENDUNGEN BEI SONNENSONDEN UND GROSSFLAECHIGEN SOLARZELLENANLAGEN]
Egon Mueller, Edgar Klippel, and Klaus Einfeld 1968 54 p refs In GERMAN Presented at the 2nd DGLR Symp. on Energy Supply in Interstellar Space, Munich, Mar. 1968 Supported in part by the Bundesmin. fuer Wiss. Forsch.
(RF-93-0; DGLR-68-003) CFSTI: HC $3.00/MF $0.65

A largely mechanized module technique for the fabrication of solar cells is described which specifically provides for resistance to thermal shock and thermal cycles. Mechanization of soldering and bonding makes this method especially suited for large-volume production. Silver lattice-foil structures joined by brazing are used for greater structural stability and to keep weight low. Air pockets and inclusions on bonded surfaces are avoided by bonding in vacuum. Transl. by K.W

N68-22258*# National Aeronautics and Space Administration. Langley Research Center. Langley Station, Hampton, Va.
THE GEOMETRIC PROPERTIES OF AN EXPANDABLE WHIRLING-MEMBRANE SOLAR-ENERGY CONCENTRATOR
John M. Jerke and Atwood R. Heath, Jr. Washington May 1968 36 p refs
(NASA-TN-D-4532) CFSTI: HC $3.00/MF $0.65 CSCL 10A

The whirling-membrane concept of solar-concentrator fabrication has been proposed for use with spacecraft-power-conversion devices because of its compact-packaging potential. Three membranes of 0.01-millimeter-thick aluminized plastic were constructed and attached to metal hubs for which the ratios of the hub radius to the membrane radius were 0.20, 0.35, and 0.50. The resulting models that had design focal lengths of 132.1 centimeters and design diameters of 3.05 meters were rotated at 71 radians per second in a vacuum chamber at pressures below 133 newtons per meter^2. The accuracy with which each membrane achieved the design paraboloidal shape was measured by an optical-ray-trace technique. The membrane with the metal hub of largest diameter gave the best concentration of energy. For this model, the focal length was 130.5 centimeters or 1 percent less than the design value. A geometric efficiency of 1.00 was obtained at a concentration ratio of 23. Membrane surface mean errors varied from −0.6° to 0.4° in the radial direction and were essentially zero in the circumferential direction. The random error has a standard deviation of 0.5° in the radial direction over most of the membrane and 0.25° in the circumferential direction. Location of supporting cables relative to the metal hub was found to be an important factor in the design of a whirling-membrane concentrator. Author

N68-22401*# National Aeronautics and Space Administration Washington, D. C.
INVESTIGATION OF THE THERMAL STABILITY OF THE MICROSURFACE OF ASTRONOMICAL MIRRORS FABRICATED FROM AMg6L ALLOY WITH CHROMIUM AND NICKEL COATINGS [ISSLEDOVANIYE NA TERMOSTOIKOST' MIKROPOVERKHNOSTI ASTRONOMICHESKIKH ZERKAL IZGOTOVLENNYKH IZ SPLAVA AMg6L S KHROMOVYN I NIKELEVYM POKRYTIYAMI]
Zh. M. Loresyan Apr. 1968 4 p Transl. into ENGLISH from Soobshch. Byurakansk. Observ., Akad. Nauk, ARM. SSR (Erevan), no. 38, 1967 p 66–71
(NASA-TT-F-11659) CFSTI: HC $3.00/MF $0.65 CSCL 11F

An experimental study was performed to determine the effects of low and high temperatures and differences in the linear expansion coefficient of the aluminum alloy AMg6L and electrolytic chromium or chemical nickel coatings on the microsurface quality of astronomical mirrors. Coatings of various thicknesses were tested at −95, +20, +60, and +100°C. Temperature variations had no effect on nickel films, but cracks appeared on the surface of chromium coatings thicker than 50 μ. Author

N68-22991*# Thermo Electron Engineering Corp., Waltham, Mass.
SOLAR THERMIONIC GENERATOR DEVELOPMENT Quarterly Report, 1 Dec. 1967–29 Feb. 1968
Apr. 1968 35 p Prepared for JPL
(Contracts NAS7-100; JPL-951263)
(NASA-CR-94402; TE4055-145-68; QR-9) CFSTI: HC $3.00/MF $0.65 CSCL 10B

During this quarter, the fabrication and test of converter T-208 have been completed. This model is the first under this program to incorporate a collector-radiator heat pipe structure. The dynamic performance of converter was almost identical to that of model T-207 in spite of a 17% reduction in collector area, but the failure of the static data to reproduce the performance data obtained dynamically has shown that the collector of converter T-208 operates at an excessive temperature. The cause of the high collector temperature is believed to be the limited area for vapor flow available at one component of the heat pipe, and it will be corrected in the construction of the following model. In addition the performance of converter T-208 was relatively low, and cesium conduction tests revealed an unusually large spacing of about 4. mils; steps will be taken to improve the positioning of parts during assembly of T-209. Author

N68-23182*# National Aeronautics and Space Administration Manned Spacecraft Center Houston, Tex
POWER GENERATION AND CRYOGENIC GAS STORAGE SYSTEMS STUDY FOR POST AAP 1–4 MANNED MISSIONS
Tony E. Redding, ed. 3 Aug. 1967 54 p
(NASA-TM-X-61072, MSC-IN-67-EP-24) CFSTI: HC $3.00/MF $0.65 CSCL 10A

A study of possible electrical power generation system (PGS) and cryogenic gas storage systems (CGSS) for the Apol

Applications (AAP) missions is summarized. Ground rules and guidelines affecting PGS and CGSS requirements were investigated, and attention was given to missions and configurations, power, and CGSS requirements as well as weights and payload margins. Candidate hardware were studied for the cryogenic gas storage systems, fuel cells, solar cell/battery systems, primary and secondary batteries, and power conditioning. Design and analysis for the PGS and CGSS included hybrid power system, command-service module fuel cell/radiator heat rejection system, and orbital storage considerations. Scheduling, costs, and programming considerations are summarized. M.W.R

N68-23528*# Radio Corp. of America, Princeton, N. J. Astro Electronics Div.
MULTI-KILOWATT SOLAR CELL POWER: ITS CRITICAL TECHNOLOGY AND HARDWARE DEVELOPMENT
[1967] 117 p Transcript of Presentation at NASA Headquarters, Washington, D. C., 13 Jul. 1967 Sponsored by NASA
(NASA-CR-94551) CFSTI: HC$3.00/MF$0.65 CSCL 10A

A program review is presented on the critical areas of technology associated with solar cell battery power systems for manned spacecraft. The technical details of what comprises a typical large manned mission solar power system are discussed, and some of the technical problems of large solar cell development are defined. They include (1) adaptability of design approach to orbits, (2) one year reliability goal of 0.995, (3) solar cell constrained to operate belly down, (4) in-orbit thrusting for orbit plane, and (5) flight vehicle envelope constraints. Pictorials and charts are given to graphically illustrate various topics discussed which include system configuration analysis, baseline system analyses, reliability enhancement of baseline system analysis, and selected system configurations. The overall development program for solar cell arrays is examined in relation to total cost of solar array development, development tasks, and the hardware and major elements of the array. B.S.D.

N68-23987*# Hittman Associates, Inc., Baltimore, Md.
SOLAR FLAT PLATE Final Report
Oct. 1966 224 p refs
(Contract NAS5-9167)
(NASA-CR-94615; HIT-206) CFSTI: $3.00 CSCL 10A

Solar thermoelectric energy conversion panels may be constructed from modules, each of which consists of an absorber, a thermoelement or thermoelectric couple, and a radiator. The absorber collects solar heat which causes a high temperature to be established. The thermoelements convert a portion of this heat to electricity, and the unconverted heat is rejected to space by the radiator. An accurate analysis has been developed, reported herein, so that the performance characteristics of the solar flat plate may be predicted for expected operational conditions. The mathematical model obtained as a result of this study contains a number of non-linear second order differential equations which cannot be solved analytically. A digital computer program therefore has been written for the IBM-7094 so that a solution may be obtained. Major emphasis has been placed in the writing of the program so that calculation accuracy and ease of use of the program will result. A comparison of the computer program results with experimental and manual calculations show good correlation. A limited parametric study has been performed and reported herein which shows characteristics to be expected for earth orbit behavior and for an application close to the sun. Author

N68-27564*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
PERFORMANCE OF AN EXPANDABLE WHIRLING MEMBRANE SOLAR ENERGY CONCENTRATOR
John M. Jerke [1967] 16 p refs Presented at the 3d Aerospace Expandable and Modular Struct. Conf., Miami Beach, Fla., 16–18 May 1967
(NASA-TM-X-59872) CFSTI: HC$3.00/MF$0.65 CSCL 10A

The whirling membrane solar energy concentrator is a preformed approximate paraboloid constructed of an aluminized plastic film which is attached to a fixed hub. The concentrator is deployed by rotation about the optical axis, and the membrane assumes the desired paraboloidal shape under the stresses imposed by centrifugal and axial loading. The concentrating ability of three whirling membrane models was determined by optical ray trace methods and the results of the investigation are presented. Dispersion of the reflected optical image in the focal plane occurred for all three models. This undesirable energy spread probably resulted from circumferential wrinkles and a deviation in the circular shape of the membrane similar to cusping or scalloping. Comparison of data for the models shows that the two larger hub models developed considerably less circumferential wrinkling than the smallest hub model. A parabolic radial cross section was generally attained for each model, but with focal distances slightly less than the design value. Estimation of the geometric efficiency indicates that the whirling membrane concentrator is applicable for relatively low-temperature space power conversion systems. Author

N68-27643*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
REVIEW OF SOLAR CONCENTRATOR TECHNOLOGY
Atwood R. Heath, Jr. and Edward L. Hoffman [1967] 19 p refs Presented at the Intersoc. Energy Conversion Eng. Conf., Los Angeles, 26–28 Sep. 1966
(NASA-TM-X-59043) CFSTI: HC$3.00/MF$0.65 CSCL 10A

Continuing development of solar concentrator technology has been directed toward the improvement of methods and materials of construction to satisfy the particular design requirements of various space power conversion devices. Descriptions of fabrication techniques as well as a brief discussion of recent results from investigations made on concentrators are presented. In the area of one-piece concentrators, the stretch-formed aluminum process has been developed to the point where concentrator accuracy compares favorably with the high quality formerly obtained only by electroforming nickel. The aluminum electroforming process has been scaled up to the point where 0.76-meter-diameter concentrators have been fabricated. In the area of expandable concentrators, a modified model of the whirling membrane concept has given improved concentration of energy, however, the design parabolic cross section has not been attained. Author

N68-27926*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
PERFORMANCE OF AN EXPANDABLE WHIRLING MEMBRANE SOLAR ENERGY CONCENTRATOR
John M. Jerke *In* AFSC Expandable and Modular Struct. Conf. May 1967 p 167–180
(L-5484)

Results of a program to investigate the whirling membrane solar concentrator concept are presented. An optical ray trace method was employed to estimate such concentrator properties as shape, focal length, and geometric efficiency. Three 3.05-m diameter models with ratios of hub diameter to concentrator diameter of 0.20, 0.35, and 0.50 were examined and results are given for each model. All models generally achieved a parabolic radial cross section, but with focal lengths of 130.7 centimeters, 129.1 centimeters, and 128.2 centimeters for the 0.20, 0.35, and 0.50 hub models, respectively. Comparison of the data for the three models shows that there was considerably less circumferential wrinkling in the 0.35 and 0.50 hub models, which were similar in behavior, than in the 0.20 hub model. Estimation of the geometric efficiency at various aperture ratios for the 0.50 hub model indicated that the whirling membrane has a concentrating ability comparable to two other expandable-type solar concentrators, and inflatable-rigidized and split-rib umbrella, which also use an aluminized plastic membrane. The whirling membrane appears to be capable of efficient operation (greater than 0.90) in the aperture ratio range near 0.04 which would make it applicable for relatively low temperature space power conversion systems. Author

N68-27974*# TRW Systems Group, Redondo Beach, Calif.
MARINER MARS POWER SYSTEM OPTIMIZATION STUDY Interim Report, 4 Mar.–31 May 1968
F. S. Osugi May 1968 41 p Prepared for JPL
(Contracts NAS7-100; JPL-952151)
(NASA-CR-95263; TRW-E-7443-3-024) CFSTI: HC $3.00/MF $0.65 CSCL 22B

The prime objective of the study is directed toward the development of an optimum Mariner-class spacecraft power system to provide improved utilization of solar array capacity and greater reliability than the present Mariner-Mars power system. The two missions identified for this study project are a Mars flyby and a Mars orbiter. Author

N68-28740# Ferranti, Ltd., Chadderton (England).
DEVELOPMENT STATUS OF SOLAR GENERATORS BASED ON SILICON PHOTO-VOLTAIC CELLS
O. Clive Butcher, Derek Basnett, and Harold George Webb *In* AFSC Performance Forecast of Selected Static Energy Conversion Devices [1967] p 829–867 refs

Design techniques for silicon solar cells, including junction, contacts, optics, and encapsulation parameters, are discussed. The performance of cells for both terrestrial and space applications is related to the operating environment. There are no known degradation mechanisms applicable to terrestrial installations. Test results show the effects of charged particle bombardment of space cells and emphasize the significance of this factor in generator design. Methods of mounting solar cells in space application are examined, using the ESRO 2 satellite as an example. More recent techniques show weight, area, and cost advantages. Author

N68-28741# Royal Aircraft Establishment, Farnborough (England). Space Dept.
RECENT DEVELOPMENTS IN SILICON SOLAR CELLS
Frederick Christopher Treble *In* AFSC Performance Forecast of Selected Static Energy Conversion Devices [1967] p 868–901 refs

State-of-the-art silicon solar cells and panel assembly are described, and the specific weight, area and cost of a typical array are estimated. Radiation damage and temperature dependence data are presented. Developments aimed at improving these parameters are reviewed, particular reference being made to the possibility of achieving a considerable reduction in specific weight by mounting very thin single crystal cells on flexible or semiflexible substrates. Experiments in this field are described and a forecast made of the specific weight and area of a flexible array of 0.004 in. cells. Work on cover slips and cements, which may lead to a reduction of cost, is discussed. Author

N68-28744# Centre National de la Recherche Scientifique, Bellevue (France). Laboratoire de Magnetisme et de Physique de Solids.
CADMIUM TELLURIDE SOLAR PHOTOCELLS [LES PHOTOPILES SOLAIRES AU TELLURURE DE CADMIUM]
Michel Rodot *In* AFSC Performance Forecast of Selected Static Energy Conversion Devices [1967] p 944–1009 refs In FRENCH and ENGLISH

After a brief historical survey, the technology used to prepare photoelectric cells in thin layers of CdTe having 5% conversion efficiency is described. For the purpose of foreseeing possible improvements, the intrinsic properties of CdTe, the thermodynamic and electronic properties of the currently known imperfections, and an analysis of the mechanism of the photovoltaic effect in $CdTe-Cu_2Te$ junctions are presented. The present performance of these cells is given, with special attention directed to the status of studies dealing with degradation by heating or irradiation. Finally, difficulties in the way of increasing the efficiency to approximately 8% obtained from single crystals and of improving the overall performance are discussed. Author

N68-28745# Allgemeine Elektricitaets-Gesellschaft, Hamburg (West Germany).
OPTICAL AND TECHNOLOGICAL PROBLEMS OF SOLAR CELL GENERATORS
Helmut H. Menke and Joachim Rath *In* AFSC Performance Forecast of Selected Static Energy Conversion Devices [1967] p 1011–1020 (See N68-28714 17-03)

Details are given on the more important test methods used to determine the physical properties of such main components of solar cell generators as the solar cells, cover slides, and adhesives to cement the cover slides to the solar cells. As the tests must be conducted under simulated space environment conditions, the main facilities are listed as solar simulator, vaccum chamber, temperature chamber, and Van de Graaff generator. Photoelectrical measurement techniques are also described. The application of the test data to solar generator design is discussed. M.G.J.

N68-28746# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
GERMANIUM SOLAR PHOTOELECTRIC CELLS. 1: EXPERIMENTAL STUDY OF PHOTOVOLTAIC CELLS AT HIGH FLUX DENSITIES
Jean Tavernier and Paul Sibillot *In* AFSC Performance Forecast of Selected Static Energy Conversion Devices [1967] p 1071–1085 refs

Germanium solar cells are shown to be well suited for high intensity solar conversion devices. Preliminary experiments have been performed up to 20 W cm^{-2} power density, and a conversion efficiency more than twice that of silicon cells was obtained. Author

N68-30751*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
PRELIMINARY ANALYSIS OF A TITANIUM ALLOY HONEYCOMB SOLAR ABSORBER HAVING BLACKENED WALLS
William J. Bifano Washington Aug. 1968 27 p refs
(NASA-TN-D-4727) CFSTI: HC $3.00/MF $0.65 CSCL 18N

A titanium alloy hexagonal honeycomb with blackened walls is considered as an absorber of collimated solar solar energy. Circular cylindrical geometry is assumed for the analysis as an approximation of the hexoganal cell structure. The apparent hemispherical emittance of such an absorber positioned over a black surface is calculated. Results are presented for cell length-to-diameter ratios of from 1 to 7 and cell diameters of 0.25, 0.5, and 1.0 in. (0.635, 1.27, and 2.54 cm, respectively). The collimated incident solar flux is assumed sufficient to attain base surface temperatures of 1860° and 2060° R (1033 and 1144 K). The corresponding weight per unit area of such an absorber is also calculated. Author

N68-31018*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
FLAT PLATE THERMOELECTRIC GENERATORS FOR SOLAR PROBE MISSIONS
Valvo Raag, Robert E. Berlin, and William J. Bifano Washington 1968 12 p refs Presented at the Intersoc. Energy Conversion Eng. Conf., Boulder, Colo., 13–16 Aug. 1968
(NASA-TM-X-52451) CFSTI: HC $3.00/MF $0.65 CSCL 10B

The design of a flat-plate thermoelectric generator for operation at 0.25 AU or less from the sun is presented. Design output is 150 watts at 28 volts. Generator electrical performance, temperature profiles, and component weights are included. Layout drawings illustrate the generator configuration. The operations of the generator under a variety of off-design conditions, in terms of variable absorptance and emittance characteristics of generator surfaces and its operating distance from the sun, is discussed. Author

N68-31096*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
2 TO 10 KILOWATT SOLAR OR RADIOISOTOPE BRAYTON POWER SYSTEM
John L. Klann Washington 1968 14 p refs Presented at the IEEE Intersoc. Energy Conversion Eng. Conf., Boulder, Colo., 14–16 Aug. 1968
(NASA-TM-X-52438) CFSTI: HC $3.00/MF $0.65 CSCL 10B

A second generation Brayton power system has been defined. Hardware components are currently being assembled for complete, ground-based power system tests. The power systems to be tested are described. Maximum system efficiency is estimated at 0.19 for two kilowatts of output, rising to about 0.27 in the range from six to ten kilowatts. Author

N68-31404*# Boeing Co., Seattle, Wash. Space Div.
LARGE AREA SOLAR ARRAY Quarterly Report—Phase 2, 1 Mar.–31 May 1968
R. C. Weikel, F. W. McAfee, J. L. Apperson, and Dwight A. Norsen Jun. 1968 252 p refs Prepared for JPL
(Contracts NAS7-100; JPL-951934)
(NASA-CR-95999; D2-113355-6, Pt. U; QR-3) CFSTI: HC $3.00/MF $0.65 CSCL 13H

Following a summary of engineering, technology, and manufacturing activities relating to the development of a large area solar array, details are presented of the various aspects of the development program. Design and requirements are stated, and the effect of boost environment on design is detailed. The latter includes the dynamic and internal loads for stowed configurations, vibration and stress-deformation analyses, the prestress conditions, and temperature distribution and temperature control aspects. Both ground and space release and deployment are covered, and electrical power source design and performance analysis are reviewed. Attention is also given to process development and material properties, quality assurance and reliability, and weight status; and critical safety margins are summarized. M.W.R.

N68-31526*# National Aeronautics and Space Administration, Washington, D. C.
SOLAR CELLS
1968 4 p
(NASA Facts S-6/3-68) GPO: HC $0.05; CFSTI: MF $0.65 CSCL 10A

Described are construction and operational parameters of solar cells for electrical power generation. The solar cell uses a silicon crystal to convert sunlight directly into electrical energy and thus provides the electrical power for unmanned space missions conducted by NASA. Phosphorus-boron containing silicon crystals in a solar cell measuring only one by two centimeters can produce a current of 60 milliamperes at four-tenth of a volt. G.G.

N68-32561*# General Electric Co., Philadelphia, Pa. Missile and Space Div.
FEASIBILITY STUDY 30 WATTS PER POUND ROLL-UP SOLAR ARRAY Final Report
N. F. Shepard, F. A. Blake, W. S. Busch, A. Latour, R. J. Kyle et al 21 Jun. 1968 258 p refs Prepared for JPL
(Contracts NAS7-100; JPL-951970)
(NASA-CR-96230; Rept.-68SD4301) CFSTI: HC $3.00/MF $0.65 CSCL 10A

This report summarizes the preliminary design and analysis of a 250-square-foot roll-up solar array which has a power-to-weight ratio of 32.3 watts per pound. The selected array configuration is presented, along with a complete description of each component within the system. Tradeoff studies and performance analyses are presented, including dynamics, structural, electrical, and weight studies. An engineering demonstration model was designed and fabricated to demonstrate the deployability of the selected flight array. Summaries of related supporting studies and activities cover thermal cycling tests, lubrication, materials, and preliminary design of ground support equipment. K.W.

N68-33207*# General Electric Co., Philadelphia, Pa. Missile and Space Div.
CADMIUM SULFIDE THIN FILM SOLAR CELL ARRAY SUB-PANEL DEVELOPMENT Final Report
F. A. Blake 15 Aug. 1968 28 p
(Contract NAS3-11821)
(NASA-CR-72439; DIN-68SD4299) CFSTI: $3.00 CSCL 10A

Advancement of the art of cadmium sulfide solar array technology from the module to sub-panel (100 cells) stage was accomplished. Twelve modules of 25 cells each were fabricated using both of the previously developed interconnection methods. These were tested and assembled into three sub-pannel units of four modules each. Procedures for sub-panel manufacture together with weight and performance data defining the present state of the CdS solar array technology are presented. Author

N68-35814*# Texas Instruments, Inc., Dallas.
DEVELOPMENT AND FABRICATION OF LITHIUM-DIFFUSED SILICON COLAR CELLS Final Report, 18 Aug.–31 Jan. 1968
D. L. Kendall and R. A. Vineyard 31 Jan. 1968 46 p refs
(Contract NAS5-10274)
(NASA-CR-97077; TI-03-68-35) CFSTI: HC $3.00/MF $0.65 CSCL 10A

The objective of this contract is to develop lithium-diffused P-on-N silicon solar cells of high conversion efficiency which display improved resistance to the effects of space radiation. The work is based on an observation of Wysocki that solar cells made with lithium-doped silicon demonstrated spontaneous annealing at room temperature after being damaged with high-energy electrons. The program involves the fabrication of experimental lots of silicon solar cells in which the basic parameters are varied, including base resistivity, crystal type, oxygen content, dislocation density, and lithium doping. Author

N68-36000*# TRW Systems, Redondo Beach, Calif.
STUDY TO ESTABLISH CRITERIA FOR A SOLAR CELL ARRAY FOR USE AS A PRIMARY POWER SOURCE FOR A LUNAR-BASED WATER ELECTROLYSIS SYSTEM, PHASE 1 Final Technical Report, 1 Jul. 1967–30 Jun. 1968
J. E. Boretz 30 Jun. 1968 549 p refs
(Contract NAS8-21189)
(NASA-CR-61979; TRW-09681-6002-R000) CFSTI: HC $3.00/MF $0.65 CSCL 10A

Parametric performance and design data were developed to assess the feasibility of using large solar array systems on the lunar surface, and to determine the compatability of the solar arrays with the lunar environment. The candidate solar array configurations selected were the flat-skirted (shaded lunar surface), leanto-skirted, and oriented-skirted; the leanto- and oriented-skirted output power profiles were found to most closely match the load profiles for the baseline mission. Baseline mission requirements are established for setting up a lunar base for supporting lunar surface exploration activities. Trade-off studies were conducted between the lunar equipment prime electrical power system (LEPEPS) and the electrolytic reactants production system (ERPS) to arrive at the most cost-effective approach. It was concluded: (1) Both single crystal silicon cells and cadmium sulfide thin films provide adequate performance. (2) The solar array–fuel cell–ERPS system concept represents the most technologically advanced system that could be flight ready by the early 1970s. (3) The use of large solar arrays on the lunar surface is feasible; they can be made compatible with the environment by employing proper design techniques. M.G.J.

N68-36630*# Fairchild Hiller Corp., Germantown, Md. Space and Electronics Systems Div.
FABRICATION FEASIBILITY STUDY OF A 30 WATT/POUND ROLLUP SOLAR ARRAY Final Report
W. G. King 15 Aug. 1968 114 p refs Prepared for JPL
(Contracts NAS7-100; JPL-951969)
(NASA-CR-97208; Rept.-652-00101-FR) CFSTI: $3.00 CSCL 10A

The results of a study to determine the feasibility of fabricating a 250 square foot roll-up solar array capable of producing 30 watts/lb. or more of electric power are summarized. Three candidate structural systems having array deployment and retraction capability were evaluated in depth through parametric investigation of the various subsystems with weight minimization as the prime criteria. The study culminated in selection of an array panel deployment/structural support system consisting of a folding beam using programmed joint motion. A preliminary design of the selected concept is presented with results of a deployment/retraction test program conducted on a full scale mechanically functioning model. Author

N68-37401*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
SPACECRAFT POWER
In its Space Programs Sum. No. 37–51, Vol. 3 30 Jun. 1968 p 29–47 refs (See N68-37397 23-11)

Spacecraft power research is reported which includes studies of: (1) solar cell standardization; solar power system definition; solar cell contacts; power subsystems applicable to the Capsule System Advanced Development project; computer programs for analyzing electronic circuits; electric propulsion power conditioning; Mars spacecraft power systems; planetary solar arrays; and thermionic converter development. S.C.W.

N69-10227*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
TRANSIENT SOLIDIFICATION OUTSIDE A COOLED PIPE WITH APPLICATION TO A SOLAR BRAYTON HEAT RECEIVER
Wellington W. Hu Washington Nov. 1968 33 p refs
(NASA-TN-D-4897) Avail: CFSTI CSCL 20M

The analysis involves time-variant heat conduction with the liquid-solid boundary moving radially through the axisymmetric heat-storage material as heat is transferred to the flowing cooling medium. Solutions were obtained by simultaneously solving the integrated nonlinear differential equations through numerical means. Quasi-steady radial heat conduction is utilized at an instant of time. Solutions for wall temperature, gas temperature, and solidification thickness along the tube for a 35-minute shadow portion of an Earth orbit are obtained for a solar Brayton heat receiver. A simplified solution neglecting the wall-temperature variation is also derived to compare with the numerical method. Author

N69-10708*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
CALORIMETRIC, OPTICAL, AND VIBRATION INVESTIGATIONS OF STRETCH-FORMED ALUMINUM SOLAR CONCENTRATORS
Marvin D. Rhodes and Conrad M. Willis Washington Nov. 1968 45 p refs
(NASA-TN-D-4889) Avail: CFSTI CSCL 10B

Three stretch-formed aluminum solar concentrators were evaluated. The models represent three phases of a program; all were 1.52-m-diam paraboloids with a nominal rim angle of $\pi/3$ rad. Calorimetric tests were made on each model to determine the improvement in model performance caused by changes in model design and fabrication. Model 3 was superior to the other models in both geometrical accuracy and specular reflectance and is considered suitable for thermionic applications. Optical-ray-trace tests were performed on models 1 and 2 to determine the magnitude and location of surface slope errors. The largest slope errors occurred near the gore seams but the region of high error was only about 8% of the total area. Ray-trace data were also used to calculate geometric efficiency by three methods. Only the random error method gave reasonable results for both models. Vibration tests on model 1 caused failure in the welds of the rim support ring structure, but subsequent calorimetric tests revealed little or no reduction in concentrator efficiency. Author

N69-11991 Bolkow Entwicklungen K. G., Munich (West Germany).
SOLAR CELLS AND THEIR APPLICATION TO SPACE TRAVELING [SOLARARZELLEN UND IHRE ANWENDUNG IN DER RAUMFAHRT]
Egon Mueller 26 Jul. 1968 80 p refs In GERMAN Presented at the 7th Symp. on Space Traveling, Brunswick, 7–12 Oct. 1968
(RF-89-0) Avail: Issuing Activity

The principle, production, and efficiency of semiconductor solar cells are described, and the properties of silicon solar cells are analyzed. Problems in connection with the dimensioning and the aggregation of modules are discussed, including spectral sensitivity, temperature effects, electrical connections, and coating materials. Factors of weight, reliability, exposure to radiation, and temperature control are considered. Performance data and configurations of representative systems are given, and tendencies of future development are discussed. Transl. by K.W.

N69-14920*# Thermo Electron Engineering Corp., Waltham, Mass.
SIX-CONVERTER SOLAR THERMIONIC GENERATOR Final Report, 10 Jan. 1967–31 Mar. 1968
T. Athanis, P. Shefsiek, and L. Lazaridis Jun. 1968 110 p refs Prepared for JPL
(Contracts NAS7-100; JPL-951770)
(NASA-CR-98712; TE4073-146-68) Avail: CFSTI CSCL 10B

A six-converter solar thermionic generator was designed, fabricated and subjected to preliminary evaluation. Six additional thermionic converters similar to those used in the generator were fabricated and individually tested. With the exception of one, each of the twelve converters produced more than 36 watts of output power at 0.7 volt output voltage, and at 2000°K emitter temperature. The average power output per converter was 37.5 watts. All converters have identical overall configuration, employing planar electrode geometry with a rhenium emitter (of about 2 cm^2 area), and a molybdenum collector separated by about 0.005 cm (2 mils) during operation. Critical parts of each converter and of the generator in general were subjected to detailed design analysis and performance evaluation. Heat flux distribution and temperature profiles, heat transfer mechanisms, and heat dissipation requirements in the generator were determined. Author

N69-15891# European Space Technology Center, Noordwijk (Netherlands). Large Astronomical Div.
LARGE ASTRONOMICAL SATELLITE SOLAR PADDLE CONFIGURATIONS AND AVAILABLE POWER
R. Somoza Paris ESRO Sep. 1964 20 p
(ESRO-TM-P-5(ESTEC)) Avail: CFSTI

A choice having been made regarding the location of the proposed four solar paddles i.e. attached to the structure around the gymbal for the stable platform so as to obtain the projection of a significant area on the plane normal to the sun's rays and to minimize the problem of occultation of reference stars, nine possible shapes are discussed. The average projected areas as a function of the direction of the solar rays are measured and an estimate made of the average power generated for each solar paddle configuration. The advantages and disadvantages of the different shapes are compared and a recommendation made as to the most suitable type. ESRO

N69-16975*# Melpar, Inc., Falls Church, Va.
THE DESIGN AND DEVELOPMENT OF A LOW TEMPERATURE BALLOON BATTERY Phase 1 Final Report, 22 May-5 Aug. 1968
5 Aug. 1968 38 p refs
(Contract NAS5-11557)
(NASA-CR-73711) Avail: CFSTI CSCL 10C

Solar energy transmission measurements of various plastic films used as solar energy collecting arrays are investigated. Heat losses were estimated and a design was evolved, serving as solar energy transmitting and heat insulating array. This array or enclosure was tested using several solar thermal storage materials of the heat of fusion type. The battery temperature was stabilized in the presence of solar heat during the daytime, using the stored heat during nights. An array of 8 air-spaced Teflon FEP film transmits 68% solar radiation, while its heat insulating value is U = 0.15 or better. Heat storage materials were tested, melting around −23°C and −25°C. These have been subjected to simulated night-time tests, indicating that the desired battery temperature (−30°C) can be maintained for more than 12 hours. Compared with water-ice a volume reduction of 70% is indicated, while the weight reduction is approximately 40%. Author

N69-17227 Florida Univ., Gainesville.
A THEORETICAL INVESTIGATION AND EXPERIMENTAL VERIFICATION OF THE TWO-PHASE HEAT TRANSFER CHARACTERISTICS OF A COMBINED SOLAR COLLECTOR-GENERATOR FOR A SOLAR AIR CONDITIONER
Gordon Lee Moore (Ph.D. Thesis) 1967 115 p
Avail: Univ. Microfilms: HC $5.60/Microfilm $3.00 Order No. 68-9543

In the interest of reducing or eliminating heat loss, a theoretical study was made of the various possible configurations which could serve the dual role of both a solar collector and an ammonia generator. The theoretical analysis of the combined solar collector-generator and the results of the series of experimental investigations indicated the following advantages resulting from combining the two units into one: (1) The undesirable heat loss that occurs between solar collector and the separate generator of previous solar refrigeration systems is eliminated in the combined collector-generator. (2) The flat plate type solar collector-generator can generate substantial amounts of ammonia even on cloudy days when only diffuse solar energy is available. (3) The solar collector-generator developed can generate the equivalent of 30 pounds of ice per day with only a 4 by 4 foot collector area. (4) The combined collector-generator has a relatively short warm-up time. Dissert. Abstr.

N69-18748*# TRW Systems Group, Redondo Beach, Calif.
STUDY AND ANALYSIS OF SATELLITE POWER SYSTEMS CONFIGURATIONS FOR MAXIMUM UTILIZATION OF POWER, PHASE 2 Technical Report, 12 Sep. 1966-31 Dec. 1968
31 Dec. 1968 139 p refs (Contract NAS5-9178)
(NASA-CR-100038; TRW-04898-H001-R0-00) Avail: CFSTI CSCL 22B

The computer program for evaluating electric power system designs, as developed in Phase 1 of the study, was fully implemented on the IBM 7094 computer. Results of the implementation for EPSOM (Electric Power System Optimization Method) were within the expected ± 1% tolerance for system efficiency. The computerization also resulted in a configuration syntheses subroutine which has proved applicable to the existing design and promises to contribute to design development of new systems and their optimization. The need to improve the reliability of satellite power systems also led in Phase I to a design for Self Regulating and Protecting (SRAP) power systems, for which the present phase of the study provided a broad spectrum of failure modes analyses. These began at the component level and progressed through the circuit and equipment levels to the power system. All detection methods studied required a significant reaction time, in order to identify a potential failure and to take positive corrective action to prevent it from occurring. It was concluded that some form of time delay protection is necessary in order to apply the SRAP concept to power systems, and further investigation of these devices was recommended. A.C.R.

N69-21088*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
CALORIMETRIC EVALUATION OF TWO CONE-COLUMN SOLAR-ENERGY CONCENTRATIONS
Marvin D. Rhodes and Conrad M. Willis Washington Mar. 1969 25 p refs
(NASA-TN-D-5109) Avail: CFSTI CSCL 10B

Two cone-column solar-energy concentrators were evaluated in this investigation. Both models had a rim angle of 0.79 radian and an effective radius of 76 cm. The first model was a simplified version of the cone-column with a rigidized cone. This model had a calorimetric efficiency of about 0.55 at an aperture radius of 8.16 solar-image radii. If this efficiency could be attained with a model utilizing a low-mass membrane cone. The cone-column would be competitive with a petalous concentrator designed for use with a Rankine cycle system. The second model was constructed to study some of the problems associated with the fabrication of an

N69-21539*# Radio Corp., of America, Princeton, N. J. Astro-Electronics Div.
CONNECTOR STRIPS: POSITIVE NEGATIVE AND TABS
Charles R. Peek and Lewis E. Boodley, inventors (to NASA) Issued 14 Jan. 1969 (Filed 21 Apr. 1966) 6 p Cl. 174-72
(NASA-Case-xgs-01395; US-Patent-3,422,213; US-Patent-Appl-SN-545535) Avail: US Patent Office

Thisn, electrically conductive connector strips for electrically and mechanically coupling a plurality of electrical elements, such as solar cells, are constructed such that the various sections thereof are joined by stress relieved areas. With particular application to the interconnection of solar cells in the formation of an array, the connectors have the ability to accomodate repeated expansion and contraction cycles and, at the same time, still maintain maximum electrical output from the array.
Official Gazette of the U.S. Patent Office

N69-22175*# Radio Corp. of America, Princeton, N. J. Astro Electronics Div.
STUDY OF POWER SUPPLY CONFIGURATIONS FOR ADVANCED NIMBUS MISSIONS Final Report, 30 Apr. 1968-31 Jan. 1969
31 Jan. 1969 167 p refs
(Contract NAS5-11549)
(NASA-CR-100529; R-3431) Avail: CFSTI CSCL 10B

In this study, various solar power conversion subsystems are compared and analyzed for possible application in future Nimbus missions. Maximum use was made of existing flight-qualified Nimbus hardware and techniques to configure alternate power subsystems that will supply more load power. System configurations having a load capability range of 200 to 500 W, orbit average and at beginning of life, are considered. As much as 350 W can be obtained for the entire two-year mission with the parallel part-time/full-time tracker system configuration under nominal operating conditions. Higher power systems would utilize the bifold solar array already developed on the Nimbus project. A separate peak load converter/regulator is suggested for all systems. A severe limitation was found to exist with the series tracker configuration: an orbit average power dissipation of more than 50 W would exist in this unit, which practically precludes its use in Nimbus application.

In addition to the distinct load power increase over the Nimbus B system realized with the parallel tracker configuration, this unit requires only the same spacecraft space as the NB system. This eliminates the possible excessive power dissipation condition that could be encountered in the NB storage modules when the shunt dissipator is activated. K.W

N69-23369*# Clevite Corp., Cleveland, Ohio.
CdS SOLAR CELL DEVELOPMENT Final Report
F. A. Shirland, W. K. Bower, W. F. Dunn, and J. B. Green 14 Mar. 1969 85 p refs
(Contract NAS3-9434)
(NASA-CR-72534) Avail: CFSTI CSCL 10B

The major objectives of this second year of the program were to continue the characterization of the stability of the plastic substrate CdS thin film solar cell and to isolate and eliminate the causes of instability whenever possible. Toward that end, a standard process laboratory fabrication line was operated throughout the entire 2 year period to yield a total of 100 acceptable quality cells each month. Of these, 75 cells each month were tested and sent to the contract monitor. The remaining 25 cells were retained and placed on various dry and wet shelf storage tests, high temperature vacuum storage tests, and various temperature cycling and continuous use tests. Those cells which showed appreciable loss of output on these various tests were removed and subjected to detailed failure analyses in an effort to determine the causes of failure. Subsequently, various constructional and fabrication process variations were evaluated as possible ways around the cell weaknesses as disclosed by the various tests and analyses. Author

N69-24137# Royal Aircraft Establishment, Farnborough (England).
THE ION ENGINE AND LARGE SOLAR ARRAY FOR THE X-5 SPACECRAFT
B. P. Day and F. C. Treble Aug. 1968 28 p refs Presented at the 1st Ann. Meeting of Brit. Intern. Soc., Southampton, Engl. 24–25 Apr. 1968
(RAE-TR-68191) Avail: CFSTI

A description is given of the ion engine and the 550 W deployable solar array proposed for the Black Arrow X5 spacecraft. Problem areas are discussed and an indication is given of the present state of development. Author (ESRO)

N69-24313# Central Mechanical Engineering Research Inst., Durgapur (India).
PROSPECTS OF SOLAR POWER PLANTS IN INDIA
M. M. Shah Aug. 1968 26 p refs
(M7) Avail: CFSTI

The theoretical and practical aspects of solar power plants are discussed and an assessment is made of the feasibility of building such plants in India. It is concluded that under present Indian conditions of materials' availability, fabrication facilities, etc., building of solar power plants would be advantageous in only a few special cases. Author

N69-27843*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
A COMPUTER PROGRAM TO DETERMINE THE EFFECT OF CHARGED-PARTICLE IRRADIATION ON SOLAR-CELL OUTPUT POWER
A. F. Obenschain May 1969 49 p refs Submitted for publication
(NASA-TM-X-63559; X-716-69-168) Avail: CFSTI CSCL 10B

A major consideration in designing a solar array is the charged particle environment in which it will operate. The computer program described here, developed to calculate the effects of charged-particle flux on the power output of a single solar cell, will greatly reduce the lengthy and laborious hand calculations now necessary in designing an array. The program transforms the particle environment of a given orbit into a 1-Mev equivalent electron flux, and degrades an individual solar-cell I-V characteristic to account for the effect of this flux. The output of the program is the value of the damage-equivalent normally incident (deni) 1-Mev electron flux and a series of current-voltage points representing the I-V characteristic of the degraded solar cell. Author

N69-28123*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
CALORIMETRIC EVALUATION OF THREE 1.5-METER-DIAMETER INFLATABLE RIGIDIZED SOLAR CONCENTRATORS
Marvin D. Rhodes Washington Jun. 1969 35 p refs
(NASA-TN-D-5234) Avail: CFSTI CSCL 10B

The calorimetric efficiency of two 1.52-meter-diameter inflatable rigidized solar concentrators has been determined in order to evaluate their potential use with solar dynamic-cycle power systems. The membranes for these models were fabricated by different construction techniques and rigidized in a simulated space-vacuum environment with different foam materials (polyurethane and epoxy). Neither model was capable of satisfying typical design requirements of dynamic-cycle systems. The polyurethane-foam model had the higher calorimetric efficiency of the two models (0.61 at an aperture ratio of 7.6 as compared with 0.43 for the epoxy-syntactic-foam model); however, both models had about the same contour accuracy. In addition, these two models were compared with an epoxy-fiber glass model rigidized at atmospheric pressure. Failure of all three models to meet the typical design requirements of the Brayton and Rankine cycle systems is due to low geometrical accuracy and low specular reflectance. Author

N69-29374*# General Electric Co., Philadelphia, Pa.
PHOTOVOLTAIC POWER SYSTEMS ON FLIGHT SPACECRAFT LUNAR ORBITER 3
C. J. Drazdauskas and M. D. Read 26 May 1969 303 p refs
(Contract NAS7-547)
(NASA-CR-100700; Doc-69SD4225) Avail: CFSTI CSCL 09E

Design and performance of the power subsystem in the Lunar Orbiter 3 are described, with emphasis on data serving the interests of power system design engineers. For the purpose of the report, the power system is defined as all those subsystems and discrete assemblies that exist for the function of supplying electrical power to the spacecraft. This includes the solar array, battery, and the associated electronics comprising the battery charge regulator, shunt relator heat dissipation elements, and circuits required for the power subsystem telemetry. In addition to background information on the project and summaries on the spacecraft and its mission, the report covers power subsystem performance, components, quality assurance, solar array tests, costs, spacecraft tests, parts and materials lists, and technical problems that were encountered K.W

N69-30038# Joint Publications Research Service, Washington, D.C.
WORKING OF HELIOSTATIONS DESCRIBED
M. M. Koltun 12 Jun. 1969 9 p Transl. into ENGLISH from Khim. i Zhizn (USSR), no. 5, 1959 p 17–22
(JPRS-48222) Avail: CFSTI

The physics of converting solar energy into electrical power is analyzed, as well as several types of devices which are capable of accomplishing this transformation. At present, there are no efficient, inexpensive, and durable systems in operation, but a Soviet power plant is in the design phase and is to be constructed within the next few years. This installation is designed to output 2.2 million kW/hr per year, and the steam from the turbine generator will power an absorption refrigerator to produce 20 tons of ice per hour. The problems and shortcomings of such a multistage cycle

system are briefly mentioned, followed by a discussion of an alternative technique utilizing thermocouples, which is less sophisticated but more efficient. This result is obtained because thermoelectric elements allow the most inefficient stage, steam, to be eliminated from the energy conversion cycle. Mention is also made of a solar electric power plant being developed for desert installation, in which parabolic mirrors are used as sun ray concentrators. A.C.R.

N69-31895*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
SOLAR ABSORPTANCES AND SPECTRAL REFLECTANCES OF 12 METALS FOR TEMPERATURES RANGING FROM 300 to 500 K
Ernie W. Spisz, Albert J. Weigand, Robert L. Bowman, and John R. Jack Washington Aug. 1969 22 p refs
(NASA-TN-D-5353) Avail: CFSTI CSCL 11F

The solar absorptance of 12 metals (Al, Cu, Au, Mo, Ni, Pt, Ag, stainless steel 304, Ta, Sn, Ti, and V) were determined over the temperature range from 250 to 550 K by two different experimental methods. Direct measurements of solar absorptance were made with a cyclic radiation method using a high intensity carbon arc solar simulator. Indirect measurements of solar absorptance were obtained from spectral reflectance measurements obtained from an integrating sphere reflectometer over the wavelength range from 0.33 to 2.16 μm. The solar absorptance data as obtained from the two different methods as well as the spectral reflectance data are presented for the 12 metals. Author

N69-32305*# Radio Corp. of America, Princeton, N.J. Astro-Electronics Div.
NIMBUS-D SOLAR-CONVERSION POWER SUPPLY SUBSYSTEM Quarterly Technical Report, 15 Dec. 1968–15 Mar. 1969
18 Jun. 1969 190 p refs
(Contract NAS5-10470)
(NASA-CR-103418; AED-R-3443; QTR-5) Avail: CFSTI CSCL 10B

Solar conversion power-supply subsystem development is reported upon in the manufacture, calibration, and engineering test stage. Intended for use in the Nimbus-D meteorological satellite, the subsystem consists of one solar array, one control module, and eight storage modules. Solar cell humidity tests, substrate procurement, evaluation of the destruct units, and module fabrication were completed. Storage module nickel-cadmium batteries were procured; acceptance testing, inspection, and fabrication of heat sinks were in progress. Control module beginning-of-life I–V characteristics were charted. Component and reliability testing, and performance characteristics are tabulated and/or illustrated. M.H.E.

N69-35592 Centre National d'Etudes Spatiales, Paris (France).
SPACE SOLAR GENERATOR DEGRADATION AND INFLUENCE ON THEIR DESIGN [DEGRADATION DES GENERATEURS SOLAIRES SPATIAUX ET INFLUENCE SUR LEUR CONCEPTION]
M. H. Daspet CERTS Determination of Radiation Doses in Space 1969 p 369–382 refs In FRENCH; ENGLISH summary

Copyright Avail: Issuing Activity

For space applications a solar generator was made for converting radiation energy into electrical energy. Several systems have been studied, but two principal versions are used. The first one is the miniaturization of a solar oven, such as those used on the ground, but the realization and utilization of a large focussing mirror in space causes difficulties. The second uses semi-conductor devices to convert the incident electromagnetic radiation into electrical energy without any focussing or concentration subsystem. This system, currently called solar generator, is utilized universally since it has been set up on more than 500 satellites. The major weakness of space solar generators lies in the vulnerability of solar cells to charged particles in space. Present operational solar cells are made of silicon, and from the basic operating principles of a p-n or n-p junction, specially designed for energetic conversion, it appears that the degradation takes place in the bulk of the silicon, the electrical properties of which are modified by collisions with the protons and the electrons. Consequently, researches have been carried out in order to find a solution to this problem. The first solution consists in protecting the cell with a filter, the function of which is to stop charged particles without interfering with the useful solar radiation. It is universally used, but it lowers the power/weight ratio of solar cells. The second solution consists in improving the electronic properties of silicon and in doing it in such a way that they are preserved during the photocell manufacture. A third solution, the most complex and onerous one, consists in elaborating a new type of solar cell, less sensitive to charged particle radiation with a better power/weight ratio, a greater strength and a lower cost price. Cadmium telluride and cadmium sulphide cells are about to offer such advantages. Author (ESRO)

N69-38442*# Radio Corp. of America, Princeton, N.J. Astro-Electronics Div.
NIMBUS-D SOLAR CONVERSION POWER SUPPLY SUBSYSTEM Quarterly Technical Report, 15 Mar. 15 Jun. 1969
5 Sep. 1969 223 p
(Contract NAS5-10470)
(NASA-CR-106009; AED-R-3472; QTR-6) Avail: CFSTI CSCL 10A

Reported is the manufacturing and qualification testing of a modified solar conversion power supply subsystem for use with the Nimbus-D meteorological satellite. The system consists of eight identical storage modules, one control module, and one solar array. Two solar cell platforms containing n-on-p silicon solar cells mounted on each side of the sun oriented platforms comprised the solar array. Post manufacturing electrical confidence tests on 10- and 6-cell solar modules were satisfactory. Data from control module, storage module, and solar array acceptance tests are included. G.G.

N69-38646*# Electro-Optical Systems, Inc., Pasadena, Calif.
DEVELOPMENT OF LIGHTWEIGHT SOLAR PANELS Summary Report, Jan. 1966 Mar. 1969
J. A. Carlson Oct. 1969 211 p refs
(Contract NAS7-428)
(NASA-CR-66832) Avail: CFSTI CSCL 10B

This report summarizes results in the development of lightweight, rigid solar panels. The specific areas which are documented in this report are related to the fabrication, assembly, and testing of demonstration panels. Presented are the design tradeoffs, optimization studies, and array and mechanisms designs which are completed. Author

N69-38783*# Princeton Univ., N.J. Dept. of Aerospace and Mechanical Sciences.
AEROSPACE SYSTEMS AND MISSION ANALYSIS RESEARCH: SOLAR ELECTRIC SPACE MISSION ANALYSIS Final Report
P. M. Lion, M. Handelsman, and J. P. Layton 15 Jan. 1969 66 p refs
(Contract NSR-31-001-078)
(NASA-CR-106089; AMS-843) Avail: CFSTI CSCL 22C

In preliminary mission analyses for solar powered, electric rocket propelled spacecraft on Mars orbiter, Jupiter flyby, and asteroid belt exploration, trajectories were undertaken within the Aerospace Systems and Mission Analysis Research (ASMAR)

Program. Mars orbiter trajectories in the years 1971, 1973, 1975, 1977 and 1979 were checked approximately using an ASMAR modification of the ITEM interplanetary trajectory computer program. Another ASMAR computer program, Gordon 1, was used to optimize solar electric propelled Jupiter flyby trajectories which identified several trajectory modes and gave an understanding of the sensitivities to launch vehicle and propulsion technology. Preliminary analyses of asteroid belt exploration missions, especially rendezvous trajectories with advanced technology, indicate an interesting and possibly important application of solar electric propulsion for various asteroid, planetoid and cometary missions.
Author

N69-40952*# Textron Electronics, Inc., Sylmar, Calif. Heliotek Div.
DEVELOPMENT OF AN INTEGRATED LIGHTWEIGHT FLEXIBLE SILICON SOLAR CELL ARRAY Quarterly Technical Report, 1 Jul. - 1 Oct. 1969
E. L. Ralph, E. F. Zimmerman, and P. M. Stella Oct. 1969 61 p
Prepared for JPL
(Contracts NAS7-100; JPL-952560)
(NASA-CR-106379; QTR-1) Avail: CFSTI CSCL 10B

The study is to provide design data that will help in the development of an integrated lightweight flexible silicon solar cell array significantly lighter and less expensive than arrays presently being designed. Included in this report are solar cell cost effectiveness comparison, a preliminary analysis of a continuous process solar cell ultra-thin cover installation process, a detailed analysis of solar cell interconnect stresses and an analysis of a ribbon substrate with associated test data.
Author

N70-11303# European Space Research and Technology Center, Noordwijk (Netherlands).
PRIMARY ENERGY SOURCES AND CONVERSION SYSTEMS
K. H. Heffels *In* ESRO Proc. of the 6th ESRO Summer School, Vol. 6: Space Power Systems: Introduction Jul. 1969 p 25-56 refs
Avail: CFSTI

This report discusses solar, chemical and nuclear energy as energy sources for space power systems. A short description of the principles, problems and the present development status of solar cells, thermoelectric and thermionic converters, heat engines, primary batteries and fuel cells is given. A brief discussion of combinations of energy sources and converters is included.
Author (ESRO)

N70-11427# Massachusetts Inst. of Tech., Cambridge. Energy Conversion and Semiconductor Lab.
ACTIVITIES CONCERNING ELECTRICAL, THERMAL, AND OPTICAL PROPERTIES OF SEMICONDUCTORS RELATED TO ENERGY CONVERSION Final Technical Report, 15 Jun. 1958 - 30 Nov. 1969
Richard B. Adler and Arthur C. Smith 1 Aug. 1969 31 p
(Contract Nonr-1841(51))
(AD-693235) Avail: CFSTI CSCL 20/12

The document presents a capsule view of work performed under the contract over its ten year period. It includes abstracts of all technical reports and theses, and bibliography of published works. Also included are types, dates, and personnel for all graduate degrees awarded, based upon theses carried out with contract support.
Author (TAB)

N70-12119*# Carnegie-Mellon Univ., Pittsburgh, Pa.
HETEROJUNCTION SOLAR CELL CALCULATIONS
R. Sahai and A. G. Milnes Nov. 1969 32 p refs
(Grant NGR-39-087-002)
(NASA-CR-49827) Avail: CFSTI CSCL 10B

Solar cell efficiencies are computed for feasible semiconductor heterojunction cells of ZnSe GaAs, GaP Si, ZnSe Ge and GaAs Ge. The analysis includes the loss in efficiency because of reflection, incomplete collection and internal series resistance. Optimum antireflection films are also calculated. The results are compared with the performances expected of Si solar cells and GaAs homojunction cells. ZnSe GaAs cells are shown to have the potential for exceeding the efficiency of both Si and GaAs cells, if interface recombination losses are small. The output voltage, voltage regulation and temperature performance should be superior to that of Si cells. The window effect in the heterojunction cell may also provide some inherent resistance to deterioration under radiation conditions.
Author

N70-12695 Johns Hopkins Univ., Baltimore, Md.
SOLAR CELL POWER SYSTEMS ON U.S. SATELLITES. PART 2: SATELLITES DESIGNED BY THE JHU, APPLIED PHYSICS LABORATORY
Robert E. Fischell IN ESRO Proc. of the 6th ESRO Summer School. Vol. : Space Power Systems: Appl. Jul. 1969 p 55-67 refs
Avail: CFSTI

This paper describes several types of conversion/energy storage systems in use at the Applied Physics Laboratory, in particular, those of Transit 1 B, 3 B and 4 B satellites. Solar arrays, storage batteries, regulation and performance are discussed.
Author (ESRO)

N70-16228# Advisory Group for Aerospace Research and Development, Paris (France).
PHOTOVOLTAIC DEVICES AND SYSTEMS
M. Rodot (CNRS, Eudon, France) and H. Daspet (CNES, Bretigny-sur-Orge, France) *In its* Space Power Systems, Pt. 2 Nov. 1969 p 503-602 refs
Avail: CFSTI

A solar photocell is defined as a device in which solar energy is absorbed and converted into potential energy of an electron gas, and this electron gas, drifting through a potential barrier, is the active fluid of a current generator. The two tasks of absorption and collection of photoelectrons can be filled in one and the same device, using an adequate semiconductor as the absorber and an adequate physical discontinuity between two solid materials, one of which is the absorber, as the potential barrier. The well-known theory of the silicon cell is summarized and the factors affecting the conversion efficiency of the cell are discussed. A photovoltaic system is an assembly of elementary photocells, each of small surface area in comparison to the total surface of the system, capable of converting the incident solar energy into electrical energy. Several problems are analyzed which arise from the conception and realization of the solar array capable of producing energy in given conditions of lighting, temperature, and space environment.
R.B.

N70-16229# Institute for Defense Analyses, Arlington, Va.
OPTIMIZATION OF ENERGY STORAGE FOR SOLAR SPACE POWER, APPENDIX 1
G. C. Szego and B. Paiewonsky *In* AGARD Space Power Systems, Pt. 2 Nov. 1969 p 603-618
Avail: CFSTI

In the area of thermal conversion of solar energy, it is assumed that energy storage should be carried out by floating a thermal storage system which stores heat energy usually in the form of latent heat of phase change, which operates in such a way as to provide thermal energy to the conversion system from storage during periods of non-illumination by the sun. Commonly obtainable conditions are discussed under which it becomes appropriate on a mass minimization basis either to store the energy during illuminated periods in the form of electrical energy or to combine thermal energy storage with electrical energy storage. An analysis is given on the basis of which the optimal system or combination can be predicted. The parameter variation limits have been chosen so that virtually all conceivable conditions of operation and performance of the conversion and storage elements are covered.
R.B.

N70-17439# Selenia S. P. A., Rome (Italy).
SOLAR GENERATOR FOR ELDO F/9 [ALIMENTATORE SOLARE PER ELDO F/9]
F. Di Mauro 29 Jul. 1968 29 p In ITALIAN Sponsored by ELDO
(Rept-RT-68/719) Avail: CFSTI
This report concerns a study for determining the position of solar cell panels on the external satellite panels taking into account the specified power requirements (38 to 40W) and the effects of the antenna shadows. Author (ESRO)

N70-17621# European Space Research and Technology Center, Noordwijk (Netherlands).
POWER SYSTEMS IN ESRO SATELLITES
A. W. Preukschat Jul. 1969 22 p Presented at the 6th ESRO Summer School, Noordwijk, Neth., 1968
(ESRO-TN-83) Avail: CFSTI
The requirements and general design of a power system that uses solar cells as power source are discussed. Detailed summaries are given of the design of the power systems in the ESRO satellites ESRO 1, ESRO 2, and HEOS A, with a description of some of the units. Author (ESRO)

N70-20627*# AiResearch Mfg. Co., Los Angeles, Calif.
RECUPERATOR DEVELOPMENT PROGRAM, SOLAR BRAYTON CYCLE SYSTEM Final Design Report
A. F. Anderson 19 Mar. 1968 270 p refs
(Contract NAS3-2793)
(NASA-CR-108945; HT-66-0207) Avail: CFSTI CSCL 10B
The results of all analytical and test work conducted during a program for the development of a recuperator to be utilized in a closed Brayton cycle space power system that uses solar energy as a heat source and argon as the working fluid are presented. The initial phase of the work was a parametric design study to determine the optimum recuperator operating conditions for the Brayton cycle. The study was followed by analysis and testing that was directed towards determining the final design configuration. The final phase of this program included fabrication and testing of a recuperator that was delivered to the NASA Lewis Research Center. A summary of the entire program is included. Author

N70-22507# European Space Research and Technology Center, Noordwijk (Netherlands).
DESIGN OF SOLAR CELL ARRAYS AND THEIR PERFORMANCE IN SPACE
Klaus K. Reinhartz *In* ESRO Proc. of the 6th ESRO Summer School, Vol. 9 Aug. 1969 p 17–33 refs
10-03)
Avail: CFSTI
The parameters are described which are important for solar generator design for spacecraft. Orbit parameter effects and the constraint effects imposed by the spacecraft are studied. Characteristics of fixed and oriented solar cell arrays and their mechanical design are also reviewed. The methods of electrical interconnection in an array are discussed, with emphasis on shadow effects and reliability considerations. Solar cell array performance in space is described, and typical values of the mass of solar generators are given. Author (ESRO)

N70-22865*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
APPLIED MECHANICS
In its Space Programs Sum. No. 37-59, Vol. 3 31 Oct. 1969 p 156–171 refs (See N70-22851 10-34)
Copyright. Avail: CFSTI CSCL 13M
Described is a multilayer-insulation thermal vacuum setup designed to evaluate degradation effects of thermal blankets for the Ranger and Mariner spacecrafts. A preliminary study of nonlinear coupled subsystems for the Mariner solar panel system shows that nonlinear effects in a structural system are caused by nonlinear coupling units that can be determined by the receptance method. A standard for the Mariner Mars temperature control flux monitor is established; set point temperature, aperture area, and the amount of electrical power in single power bids are calibrated so that the remaining variable width of the power pulse to the cone heater is the number of power bits. The receptance coupling computer program is extended to treat random nonstationary phenomena as well. G.G.

N70-22907*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
THERMAL SYSTEM DESIGN
In its Conceptual Design of a High Energy Astronomy Obs. 16 Feb. 1970 22 p refs
Avail: CFSTI
Preliminary results are presented for an effectiveness analysis of the HEAO thermal control system. The analysis consists of establishing characteristic parameters associated with the thermal control system, determining the values of the parameters, and generating a numerical measure of effectiveness for two thermal control concepts for the satellite. The values of the characteristic parameters were related to the solar arrays only. The thermal control concepts analyzed consist of a baseline system which utilized paint only. The vehicle configuration was the baseline consisting of the solar arrays mounted to the sides of the spacecraft with the center panel perpendicular to the sunline. Author

N70-22921*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
POWER SYSTEM DESIGN, APPENDIX H
In its Conceptual Design of a High Energy Astronomy Obs. 16 Feb. 1970 32 p refs
Avail: CFSTI CSCL 10B
Design and sizing of the power system and its components were based on the maximum power capability of the surface area available for the solar array, based on the fact that power requirements are likely to increase. Maximum power available is limited to 820 watts, which includes 260 watts available for contingency. The problems emphasized in the design include the preliminary solar array layout, preliminary power system design, operational analysis, batteries, and load sharing. The power system design is based on use of Apollo telescope mount equipment where possible. R.B.

N70-24832# Gesellschaft fuer Weltraumforschung m.b.H., Bad Godesberg (West Germany).
SPACE EXPERIMENT POWER SUPPLIES
F. W. Kraemer *In* Univ. Coll., London Prelim. Design of a Cosmic X-ray Survey Expt. Oct. 1969 p 51–54 refs

Avail: CFSTI
The general design requirements of satellite power supplies, with particular reference to converter design is considered. It is assumed that the spacecraft includes a primary power source(e.g. solar cells and storage batteries), and the necessary power conditioning and control subsystem, in order to provide an unregulated DC supply at the interface between the spacecraft and the experiment. The experiment package itself incorporates a converter (or converters) to produce the voltage levels required by the individual units of the instrument. Author (ESRO)

N70-26500*# Heliotek, Sylmar, Calif.
DEVELOPMENT OF AN INTEGRATED LIGHTWEIGHT FLEXIBLE SILICON SOLAR CELL ARRAY Quarterly Technical Report, 1 Jan. – 1 Apr. 1970
E. L. Ralph, E. F. Zimmerman, and P. M. Stella 1 Apr. 1970 54 p Prepared for JPL
(Contracts NAS7-100; JPL-952560)
(NASA-CR-109527; QTR-3) Avail: CFSTI CSCL 10B

Results of a program to develop design data which will contribute to reduced cost and weight characteristics for lightweight, flexible solar cell arrays, are reported. Studies conducted include: (1) cost effectiveness comparison of solar cell coverglasses including conventional platelet, integral, and ribbon concepts; (2) interconnector flexure/tensile and thermal cycling study; and (3) wraparound interconnected module manufacutring feasibility and cost study. Author

N70-28421*# Lockheed Missiles and Space Co., Sunnyvale, Calif. NASA Agena Systems Engineering.
SERT 2 SOLAR ARRAY Final Report
4 May 1970 141 p revised
(Contract NAS3-11512)
(NASA-CR-72706; LMSC-A941440-Rev) Avail: CFSTI CSCL 10B

The module level test program of those tests are reported which were required to demonstrate that the flight worthiness of the original solar array module design had not been invalidated by the modifications required by the SERT II Program, and that the SERT II solar arrays would withstand the vibration levels of a THORAD launch. The following tests were conducted: (1) deployment mechanism engineering evaluation tests, (2) release mechanism evaluation tests, (3) vibration confidence tests, and (4) flight acceptance tests. A thorough review of the designs, hardware, test programs, test data, engineering analysis, and product assurance assessments of the SERT II Solar Array has been completed. It is concluded that the solar arrays are flight worthy. Author

N70-29273# Defense Documentation Center, Alexandria, Va.
SOLAR CELLS AND SOLAR PANELS, VOLUME 1 Report Bibliography, Jan. 1958 Oct. 1969
Jan. 1970 114 p refs
(AD-700500; DDC-TAS-69-74-1-Vol-1) Avail: CFSTI CSCL 10/2

An annotated bibliography is provided of documents in which performance characteristics of various solar cells, particularly types containing gallium arsenides, silicon, or cadmium sulfides, are evaluated. Other reports include solar-cell fabrication, development of solar-cell power systems generating higher electrical power levels, in-flight solar-cell degradation studies, and systems for orienting solar panels continuously toward the sun. Author (TAB)

N70-29807*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
GEOMETRIC PROPERTIES OF A MODIFIED WHIRLING-MEMBRANE SOLAR-ENERGY CONCENTRATOR
John M. Jerke and Atwood R. Heath, Jr. Washington Jun. 1970 43 p refs
(NASA-TN-D-5859; L-6837) Avail: CFSTI CSCL 10B

The geometry of three modified paraboloidal whirling-membrane solar-concentrator models of 3.05-m diameter was measured by using an optical-ray-trace technique. The membranes were fabricated of 0.01-mm-thick aluminized plastic, attached to metal hubs, and rotated at 71 rad/s in a vacuum chamber. Geometric properties such as focal length, mean and standard-deviation errors, and geometric efficiency for three models with different metal-hub diameters are discussed and compared with results for a similar whirling-membrane model of an earlier investigation. Author

N70-30140# British Aircraft Corp., Filton (England). G. W. Technical Publications Dept.
A STUDY OF ADVANCED SOLAR ARRAY DESIGN Quarterly Report, 1 Aug. 31 Oct. 1969
K. K. Reinhartz, comp. (ESTEC) and D. W. Mann, comp. Paris ESRO Nov. 1969 52 p Sponsored by ESRO Prepared jointly with E. Turner (Elec. Instr.) Ltd.
(Contract ESTEC-623/68sl)
(ESRO-CR-12; QR-3) Avail: CFSTI

This third quarterly report on solar array design deals with the mechanical system, cell attachment, quality assurance, panel design, cushioning materials, array frequency response, and discusses future tasks. Author (ESRO)

N70-30210# European Space Research and Technology Center, Noordwijk (Netherlands).
CALIBRATION OF SOLAR CELLS
K. H. David Nov. 1969 15 p refs Presented at the 6th ESRO Summer School, Noordwijk, Neth., 1968
(ESRO-TN-79) Avail: CFSTI

Reasons are given for the interest in standard solar cells accurately calibrated in respect of AMO (Air Mass Zero) short-circuit current. Calibration of solar cells can be performed onboard a satellite or a balloon. Another method rests on the determination of the absolute spectral response of the cells. Calibrations of solar cells in respect of AMO short-circuit current can also be obtained from measurements in terrestrial sunlight at different solar elevations. The principles of these methods are outlined and their mutual advantages and disadvantages are discussed. Author (ESRO)

N70-30228# Brown Univ., Providence, R.I.
PHOTOVOLTAIC SOLAR ENERGY CONVERSION
J. J. Loferski *In* ESRO Proc. of the 6th ESRO Summer School, Vol. 8: Space Power Systems: Photovoltaic Energy Conversion Nov. 1969 p 13-30 refs
Avail: CFSTI

Expressions for the maximum power, current, and voltage to a matched load connected across an illuminated photovoltaic cell are derived along with ones for the maximum efficiency for conversion of monochromatic, black-body, and solar radiation. The expressions depend on the reverse saturation current i sub r and the short-circuit current i sub s of the illuminated photovoltaic cell. The physical origins of these two parameters are considered in detail and expressions for the spectral response of the cells are derived. Expressions for the solar energy conversion efficiency of photovoltaic solar cells as a function of energy gap are also presented. Author (ESRO)

N70-30229# Brown Univ., Providence, R.I.
PERFORMANCE OF ACTUAL SOLAR CELLS
J. J. Loferski *In* ESRO Proc. of the 6th ESRO Summer School Vol. 8: Space Power Systems: Photovoltaic Energy Conversion Nov. 1969 p 31-45 refs
Avail: CFSTI

The factors responsibe for the differences between the theoretical and observed efficiencies of silicon cells are discussed. These include the internal series and shunt resistances, the values of minority carrier lifetime and diffusion length, and surface recombination losses and reflection and transmission losses. The temperature dependence of cell parameters is discussed and its relation to output power and voltage is considered. Author (ESRO)

N70-30231# European Space Research and Technology Center, Noordwijk (Netherlands).
THIN-FILM SOLAR CELLS
K. H. Heffels *In* ESRO Proc. of the 6th ESRO Summer School Vol. 8 Space Power Systems: Photovoltaic Energy Conversion Nov. 1969 p 77 93 refs
Avail: CFSTI

The potential and limitations of single-crystal solar cells for large-area arrays are reviewed and general design requirements, possibilities, and problems in thin-film solar cell construction are discussed. The state of the art in the fabrication of gallium

arsenide, cadmium sulphide, and cadmium telluride thin-film solar cells is reviewed and details of their characteristics are given. Author (ESRO)

N70-30232# European Space Research and Technology Center, Noordwijk (Netherlands).
CALIBRATION OF SOLAR CELLS
K. H. David *In* ESRO Proc. of the 6th ESRO Summer School Vol. 8: Space Power Systems: Photovoltaic Energy Conversion Nov. 1969 p 95-104 refs
Avail: CFSTI

Reasons are given for the interest in standard solar cells accurately calibrated in respect of AMO (Air Mass Zero) short-circuit current. Calibration of solar cells can be performed onboard a satellite or a balloon. Another method rests on the determination of the absolute spectral response of the cells. Calibrations of solar cells in respect of AMO short-circuit current can also be obtained from measurements in terrestrial sunlight at different solar elevations. The principles of these methods are outlined and their mutual advantages and disadvantages are discussed. Author (ESRO)

N70-30560# Fraunhofer-Gesellschaft, Stuttgart (West Germany). Inst. fuer Technische Physik.
PROBLEMS OF ROOM HEATING IN SUMMER [ZUR PROBLEMATIK DER SOMMERLICHEN RAUMERWAERMUNG]
K. Gertis *In its* Examples of Appl. Res. Jun. 1969 p 60-63 In GERMAN
Avail: CFSTI

Modern buildings have large window glass surfaces and in summertime, depending on glass type and wall material, room temperatures can become intolerable. To solve this problem, architects should choose suitable building materials for inner rooms rather than use expensive air-conditioning systems. ESRO

N70-32426# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
HIGH TEMPERATURE SOLAR FURNACE
V. A. Baum et al 3 Mar. 1970 9 p refs Transl. into ENGLISH from Geliotekh., Akad. Nauk Uzb. SSR, no. 2, 1969 p 56-59
(AD-704754; FTD-HT-23-62-70) Avail: CFSTI CSCL 13/1

Description of the furnace and the absolute calorimeter for investigation power characteristics of solar power furnaces are given and also power characteristics and the region of temperatures in which thermophysical and radiation properties of refractories can be investigated are presented. Author (TAB)

N70-36227# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
MATCHING A THERMIONIC CONVERTER WITH A SOLAR CELL IN A SOLAR POWER ARRAY
U. A. Arifov et al 25 Feb. 1970 7 p refs Transl. into ENGLISH from Geliotekhnika, Akad. Nauk Uz. SSR (Tashkent), no. 1, 1969 p 41-43
(AD-704002; FTD-HT-23-42-70) Avail: CFSTI CSCL 10/2

The aim of the report is to determine the possibility of combining a high-temperature thermionic converter with a solar cell with partial use of its outer surface as the cathode with the introduction of the concentrator parameters corresponding to glass projector mirrors. Author (TAB)

N70-37465*# Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.
STUDY OF FABRICATION TECHNIQUES FOR SiC SOLAR CELLS Final Technical Report
R. B. Campbell and H. S. Berman Jul. 1970 78 p refs
(Contract NAS2-5595)
(NASA-CR-73444; WANL-PR-TTT-001) Avail: CFSTI CSCL 10B

Silicon carbide unijunction diodes were investigated for use as possible solar cells. The devices can be used in this manner, although the overall conversion efficiency of solar energy into electrical energy is much lower than Si diodes. This lower efficiency is due mainly to fewer photons of proper energy available for conversion, reflection losses, and poor collection efficiency in the SiC diode. Both grown and diffused junctions were investigated. A graded junction structure with a junction depth of 15 microns was determined to be optimum. Techniques for applying gridded contacts were developed. The single junction cells exhibited maximum power at 250 C although they were operable at reduced efficiency to 400 C and would survive temperatures to 1000 C without damage. The cells operated satisfactorily when connected in series and parallel configurations. Several other cell structures such as the multiple junction and multiple transition were investigated. These structures show a greatly increased efficiency over the single junction cell. Author

N70-38210# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
SOLAR PANEL TEST SET
William E. Ray Feb. 1970 29 p
(Contract NOw-62-0604-C)
(AD-707345; APL-TG-1103) Avail: CFSTI CSCL 14/2

The report describes the Solar Panel Test Set developed for testing solar cell panels in artificial sunlight at an equivalent sunlight intensity of 140 mW/sq.cm. The test set uses iodine-quartz (tungsten) lamps as the radiant-energy source, and the emerging radiation is uniformly reflected and totally diffused. An air conditioner, which is part of the test set, provides the cooling air necessary to control the temperature of the solar panel under test. The methods of calibrating the test set are described, and the accuracy of the measurements obtained when using artificial light as the radiation source is discussed. Author (TAB)

N70-40234* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
DEVICE FOR DIRECTIONALLY CONTROLLING ELECTROMAGNETIC RADIATION Patent
Morris Perlmutter and John R. Howell, inventors (to NASA) Issued 18 Jan. 1966 (Filed 5 Mar. 1964) 5 p Cl. 126-270
(NASA-Case-XLE-01716; US-Patent-3,229,682; US-Patent-Appl-SN-349778) Avail: US Patent Office CSCL 09E

An apparatus is described which can be used for either directing the emission of electromagnetic radiation in preferred directions or absorbing electromagnetic radiation only from desired angular ranges. Solar energy is directed toward an energy converter by selectively arranging the absorbing and reflecting surfaces of the device. R.B.

N70-43081*# Heliotek, Sylmar, Calif.
DEVELOPMENT OF AN INTEGRATED LIGHTWEIGHT FLEXIBLE SILICON SOLAR CELL ARRAY Final Report
E. L. Ralph, E. F. Zimmerman, and P. M. Stella [1970] 121 p
Prepared for JPL
(Contract NAS7-100; JPL-952560)
(NASA-CR-110913) Avail: NTIS CSCL 10B

A comprehensive and complete description of the pertinent portions of this program in a self-contained format is presented. The objective of this program was to develop methods and analytical techniques which could be used to fabricate an integrated lightweight flexible silicon solar cell array blanket with the following capabilities: (1) providing 120 watts per pound of array weight, (2) being manufactured at a cost of $100 per watt of raw power, and (3) being produced in modular prefabricated sections. The study effort was divided into seven major tasks in order to examine individual components comprising the total array concept. Author

N71-11056* Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
SOLAR CELL SUBMODULE Patent
Robert K. Yasui, inventor (to NASA) Issued 3 Feb. 1970 (Filed 20 Apr. 1966) 5 p Cl. 136-89; Int. Cl. H01m Sponsored by NASA
(NASA-Case-XNP-05821; US-Patent-3,493,437;
US-Patent-Appl-SN-545223) Avail: US Patent Office CSCL 10B

Methods of constructing matrices of submodules for solar cells are described. The cells in each submodule are arranged in parallel and one terminal of each cell is connected near one end, with an undulative busbar having raised portions between the points of contact of the busbar with each of the cells. A second busbar, which includes a group of protruding tabs, is connected to each cell near the other end, with the tabs extending from it. After the cells forming each submodule are connected to the two busbars, the submodule includes the two bars as an integral part. The submodule may then be calibrated to determine its energy conversion characteristics. R.B.

N71-11063# Royal Aircraft Establishment, Farnborough (England).
LARGE SOLAR ARRAY DEVELOPMENT IN UK
F. C. Treble Jan. 1969 28 p refs Presented at the 7th IEEE Photovoltaic Specialists Conf., Pasadena, Calif., 19-21 Nov. 1968
(RAE-TR-69007) Copyright. Avail: NTIS

Aspects of large solar array technology are reviewed, with particular reference to the development of an experimental 560 W deployable array. The array consists of very thin silicon solar cells mounted on Kapton polyimide film. It is stowed by folding the Kapton concertina fashion into rectangular compartments and deployed by pneumatically-actuated telescopic masts. Deployment is initiated by duplicated pyrotechnic actuators and takes about two minutes to complete. The estimated weight of the 78 sq ft array, including stowage compartments, cushioning, and deployment mechanism, is 25.2 lb, giving a power-weight ratio of 22.3 W/lb at 55 C. Author

N71-13427*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena. Engineering Mechanics Div.
PARAMETRIC STUDY OF THE PERFORMANCE CHARACTERISTICS AND WEIGHT VARIATIONS OF LARGE-AREA ROLL-UP SOLAR ARRAYS
J. V. Coyner, Jr. and R. G. Ross, Jr. 15 Dec. 1970 31 p refs
(Contract NAS7-100)
(NASA-CR-115821; JPL-TR-32-1502) Avail: NTIS CSCL 10B

An analysis has been conducted to determine the relationships between the performance characteristics (power-to-weight ratio, blanket tension, structural member section dimensions, and resonant frequencies) of large-area roll-up solar arrays of the single-boom, tensioned-substrate design. The study includes the determination of the size and weight of the base structure supporting the boom and blanket and the determination of the optimum width, blanket tension, and deployable boom stiffness needed to achieve the minimum-weight design for a specified frequency for the first mode of vibration. A computer program has been used to generate a set of plots that provide optimum structural sizing and estimated weights for arrays with blanket areas ranging from 100 to 400 square feet and for first-mode natural frequencies ranging from 0.03 to 0.7 Hz. Use of these plots enables a quick evaluation of the potential merits of a proposed roll-up array. Author

N71-15622* Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
HIGH TEMPERATURE LENS CONSTRUCTION Patent
Kenneth R. Lorell, inventor (to NASA) Issued 3 Feb. 1970 (Filed 22 Jun. 1966) 5 p Cl. 350-213; Int. Cl. G02b3/00, 7/02 Sponsored by NASA
(NASA-Case-XNP-04111; US-Patent-3,493,291;
US-Patent-Appl-SN-560969) Avail: US Patent Office CSCL 20F

Described is a lens assembly for solar furnace or solar simulator entrances. To prevent lens destruction by operational heat, the lens assembly is made up of a multiplicity of identical quartz lens blocks carefully clustered together in a side-by-side, continuous relationship within a common plane to form compact lens units. Relief openings between the ends of adjacent segments contain spherical keys to prevent displacements of individual lens blocks. G.G.

N71-16462*# Lockheed Missiles and Space Co., Sunnyvale, Calif. SSD Power Systems.
EVALUATION OF SPACE STATION SOLAR ARRAY TECHNOLOGY AND RECOMMENDED ADVANCED DEVELOPMENT PROGRAMS First Topical Report
28 Dec. 1970 544 p refs
(Contract NAS9-11039)
(NASA-CR-114828; LMSC-A981486) Avail: NTIS CSCL 22B

The technology and analytical techniques to support the development of a solar power system for large space stations are discussed. The goals of the program are to: (1) establish design requirements, (2) perform technology evaluation of existing techniques, (3) identify specific areas where technology advancement is needed, and (4) prepare a plan for development of the required technology. Author

N71-16472*# Radio Corp. of America, Princeton, N.J. Astro-Electronics Div.
STUDY TO DETERMINE AND IMPROVE DESIGN FOR LITHIUM-DOPED SOLAR CELLS Quarterly Report, 1 Oct. 31 Dec. 1970
T. Faith, G. Brucker, and A. Holmes-Siedle 10 Jan. 1971 23 p refs Prepared for JPL
(Contracts NAS7-100; JPL-952555)
(NASA-CR-116220; AED-R-3692F; QR-6) Avail: NTIS CSCL 10B

The action of lithium in producing a recovery or spontaneous annealing of radiation damage in bulk silicon and silicon solar cells is discussed. Analytical techniques to characterize the radiation resistance of lithium-doped solar cells and its dependence on the materials and processes used to fabricate the solar cells are presented. Recommendations for an improved design of lithium-doped solar cells are included. Author

N71-17248# Communications Satellite Corp., Washington, D.C.
FOREIGN SOLAR CELL SYMPOSIUM Summary Report
Denis J. Curtin [1969] 49 p Conf. held at Washington, D.C., 22 Sept. 1969; sponsored by Commun. Satellite Corp.
Avail: NTIS

The proceedings of a conference on the manufacture of silicon solar cells are presented. Topics discussed are a description of foreign solar cell manufacturing processes, manufacturing facilities, cell efficiencies, cell prices, types of cell contacts, radiation resistance of solar cells, and solar cell interconnects. Thin film solar cells, including cadmium sulfide and cadmium telluride solar cells, are discussed. An evaluation of the present status of the thin film cell work in Europe to determine when the cell might be fully developed is reported. Author

N71-19649*# Hughes Aircraft Co., Culver City, Calif.
PRIME POWER SYSTEMS, PART 6
In its Parametric Analysis of Microwave and Laser Systems for Commun. and Tracking, Vol. 3 Feb. 1971 p 475-523 refs

Avail: NTIS CSCL 10A

Three types of prime power systems for spacecraft power supplies are discussed. The systems are: (1) solar power systems which include solar thermoelectric systems, solar thermionic systems, and solar dynamic systems, (2) nuclear power systems using radio isotope sources or reactor dynamic systems, and (3) chemical power systems in the form of electric batteries and fuel cells. The effect of mission duration, power requirements, environment, and goals on the selection of power sources is presented. Author

N71-20273* Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
ROLL-UP SOLAR ARRAY Patent
Herman P. Valentijn, inventor (to NASA) Issued 21 Oct. 1969 (Filed 9 Nov. 1967) 7 p Cl. 244-1; Int. Cl. B64g1/10, 9/00
Sponsored by NASA
(NASA-Case-NPO-10188; US-Patent-3,473,758;
Us-Patent-Appl-SN-681687) Avail: US Patent Office CSCL 10B

A rollup solar array is described which consists of a plurality of arcuate solar panels furled on a tapered drum for spacecraft storage during launch. For space erection, the drums are rotated to extend the arcuate panels out from and around the spacecraft. An arcuate hollow beam along each panel edge stiffens the cantilevered panel. The beams are flattened as they are coiled on the drum and return to their hollow shape as they are uncoiled. Serrations in the beams avoid overstressing as the beams are flattened and opened. Official Gazette of the U.S. Patent Office

N71-20471*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
SERT 2 SPACECRAFT ELECTRICAL POWER SYSTEM
Richard J. Krawczyk Washington Mar. 1971 22 p
(NASA-TM-X-2234; E-5990) Avail: NTIS CSCL 22B

The SERT 2 spacecraft utilizes a 1.5-kW solar array as the primary source of electrical power. The spacecraft power system controls this power as required for housekeeping functions, experiments, and ion thruster system. To meet mission objectives, three separate systems were designed and implemented - regulated dc power, unregulated dc power, and ac power. Extensive ground command capability allows versatility of configuration for normal as well as abnormal flight conditions. Redundancy, fusing, diode isolation, and automatic switching were employed to minimize possibilities of mission critical component failures. Design objectives have been demonstrated in flight. Author

N71-20727*# Boeing Co., Seattle, Wash. Space Div.
LIGHTWEIGHT SOLAR PANEL DEVELOPMENT
Walter A. Hasbach Pasadena, Calif. JPL 15 Mar. 1971 36 p
Prepared for JPL
(Contracts NAS7-100; JPL-952571)
(NASA-CR-117349; JPL-TR-32-1519) Avail: NTIS CSCL 10A

Technical information is reported concerning the preliminary design, analysis, fabrication, and test of a lightweight solar panel made of a built-up beryllium structure with an active cell area of 29 sq ft. Evaluations are presented of the results of the modal survey, reverberant acoustic, random vibration, sinusoidal vibration, static load, thermal-vacuum-shock, substrate frequency, and power output tests. Author

N71-21206*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
THERMAL CYCLING TEST OF A FLEXIBLE SOLAR CELL MODULE
A. F. Forestieri, A. F. Ratajczak, and T. M. Klucher Mar. 1971 15 p
(NASA-TM-X-52995) Avail: NTIS CSCL 10A

A thermal cycling test was performed on a representative module of a flexible rolled-up solar array. The experiment was designed to expose the module to temperature cycles between 87 C in simulated sunlight and -108 C in darkness at a pressure of 10 to the minus 7th power torr. Conditions were chosen to simulate the temperature profile the array would experience while in orbit. The test module was exposed to over 2000 such cycles. The results showed that changes in open-circuit voltage and short-circuit current were within measurement error. The cover glasses did not crack or delaminate and the soldered silver mesh interconnect did not fail. Stains were visible on the module and there was a very slight darkening of the fiberglass reinforcing in the Kapton substrate. This did not appear to affect performance. Author

N71-22561*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena. Guidance and Control Div.
DESIGN AND DEVELOPMENT OF A 66-W/kg 23-m SQUARE ROLL UP SOLAR ARRAY
W. A. Hasbach *In its* JPL Quarterly Tech. Rev., Vol. 1, No. 1 Apr. 1971 p 68–77 ref
Copyright. Avail: NTIS HC$6.00/MF$0.95 CSCL 10A

Future space missions require greater power output, lighter weight, and decreased stowed volume for solar arrays. A program was initiated to develop the technology for a roll-up solar array by preparing a detailed design, performing the associated analyses, fabricating an engineering development model, and subjecting the engineering model to a comprehensive test program consisting of both environmental and developmental tests. The design and testing of the 66-W/kg (30-W/lb), 23-sq m (250 sq ft) roll-up solar array developed is described. Author

N71-23700*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE GENERATION OF POLLUTION FREE ELECTRICAL POWER FROM SOLAR ENERGY
William R. Cherry Mar. 1971 18 p refs
(NASA-TM-X-65497; X-760-71-135) Avail: NTIS CSCL 10B

A study is reported to determine the feasibility of electrical power plants, utilizing solar energy, to meet future US power demands. Investigation of a pollution free method using photovolaics on the ground indicates that sunlight falling on about 1% of the land area of the 48 states could provide the total electrical power requirements of the U.S. in the year 1990. In addition, the findings indicate that while the cost of producing solar arrays by today's methods prohibits their use for large-scale terrestrial plants, the cost may become acceptable as conventional fuels become scarcer and more expensive. D.L.G.

N71-23714*# General Electric Co., Philadelphia, Pa.
ROLLUP SUBSOLAR ARRAY. VOLUME 2: DETAILED TEST RESULTS Final Report
N. Shepard, P. Perez, K. Hanson, and R. Ross. (JPL) 1 Feb. 1970 340 p refs
(Contract NAS7-100; JPL-952314)
(NASA-CR-118006; DOC-70SD4286-Vol-2) Avail: NTIS CSCL 10A

The final assembly and system tests of the 30 Watt per pound rollup solar array engineering development unit are reported. Test results are described, analyzed and compared with analysis reported previously. Thermal bending tests of sections of the BISTEM boom and results are included. The test results have been assessed with respect to future qualification testing of a rollup solar array or integration with a spacecraft and recommendations for future programs are presented. Author

N71-25311*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
RESULTS FROM THE ATS 3 REFLECTOMETER EXPERIMENT
James B. Heaney *In its* Significant Accomplishments in Sci. and Technol. at Goddard Space Flight Center 1970 p 238–240

Avail: NTIS HC$6.00/MF$0.95 CSCL 04A

Highly reflective specular materials having aluminum or silver surfaces either uncoated or protectively coated together with Alzak, the material that comprises the outer shell of the OAO spacecraft, were evaluated. Coating samples were thermally insulated from their surroundings and their surface reflectances relative to a standard surface were monitored periodically by ATS 3 reflectometer. Spectral variations in the degradation processes and identifications of damage causes and mechanisms were observed. Alzak data confirmed laboratory tests that proved this material to be potentially unstable; solar absorptance of unshielded samples increased from initially 15% to 26% after 2000 hours of solar

exposure in orbit. Results demonstrated that dielectric film coated aluminum produces a thermal control surface comparable to white paint but of better stability. G.G.

N71-26155* Goodyear Aerospace Corp., Akron, Ohio.
THERMALLY ACTIVATED FOAMING COMPOSITIONS Patent
Charles E. Welling, inventor (to NASA) Issued 2 Dec. 1969 4 p Filed 19 Sep. 1968 Cl. 260-2.5; Int. Cl. C08g22/44 Continuation-in-part of US Patent Appl. SN-553264, filed 25 May 1966 Sponsored by NASA
(NASA-Case-LAR-10373-1; US-Patent-3,481,887; US-Patent-Appl-SN-761007) Avail: US Patent Office CSCL 11D

A storage stable, thermally actuatable, foamable composition is described. The composition comprises a hydroxyl terminated prepolymer, 4, 4 prime- diphenyl methane diacyl azine, bisphenol adduct of 4, 4 prime- diphenyl methane diisocyanate, a surfactant and a catalyst. Official Gazette of the U.S. Patent Office

N71-26726* Hughes Aircraft Co., Los Angeles, Calif.
SOLAR PANEL FABRICATION Patent
Preston S. Du Pont, inventor (to NASA) Issued 23 Feb. 1971 5 p Filed 17 May 1967 Cl. 156-212; Int. Cl. B29c17/04 Sponsored by NASA
(NASA-Case-XNP-03413; US-Patent-3,565,719; US-Patent-Appl-SN-640456) Avail: US Patent Office CSCL 10A

Methods and apparatus are discussed for precisely fabricating solar cells on a substrate. The solar cells are mounted face down in a flexible mat. The mat is then bent to the configuration the cells will have in final assembled form, and then a substrate is bonded to the backs of all the cells at one time. Official Gazette of the U.S. Patent Office

N71-28586 California Univ., Los Angeles.
THERMAL BEHAVIOR AND DESIGN OF CELLULAR MATRIX-POROUS BED SOLAR THERMAL CONVERTERS
Olufemi Akintonde Lalude (Ph.D. Thesis) 1969 339 p
Avail: Univ. Microfilms Order No. 70-14299

Studies of thermal performance of honeycomb structures when they are used to protect solid absorbers with no fluid transpiration through the honeycombs as well as porous absorbers with fluid transpiration through the honeycombs and absorbers were made. In the case of no fluid transpiration, a simple theoretical model which assumed uncoupled heat transfer by radiation, conduction, and free convection tended to underpredict temperature distribution in an effective emittance from the rectangular honeycombs with clear resin-overcoated-aluminized paper walls. In the case of air transpiration, a theoretical model was found to agree quite well with results of tests performed with an experimental module fitted with a number of rectangular honeycombs. The temperature distribution in and the thermal performance of honeycomb-porous bed solar thermal converters of the transpiration type were predicted using a theoretical model. The coupled integral energy equations obtained by carrying out energy balances on the various converter componnets were solved by the method of undetermined coefficients(collocation). Dissert. Abstr.

N71-31939# Clevite Corp., Cleveland, Ohio. Electronic Research Div.
IMPROVEMENTS IN CdS THIN FILM SOLAR CELLS Final Technical Report, 1 Nov. 1969 – 31 Oct. 1970
William F. Dunn Wright-Patterson AFB, Ohio ARL Jan. 1971 82 p refs
(Contract F33615-68-C-1182)
(AD-723315; ARL-71-0015) Avail: NTIS CSCL 10/2

The report is concerned with two areas in the cadmium sulfide thin film solar cell development program: (1) a report on space flight testing of CdS cells and (2) results of a development program for improving the stability and efficiency of the standard CdS cell. Two space flight tests of CdS cells are reported. The first test, ARX-701, contained two CdS panels on the OV1-13 Satellite The second space flight test contained one CdS panel, ARX-901, and was flown on the OV1-17 Satellite. A development program for obtaining engineering measurements from the CdS cell was carried out. A study was made of heating effects on the cadmium sulfide thin film cell after formation of the barrier layer. Additional investigations were made of low pressure laminations, a silver coated glass powder for metallized substrate use and variations in gridding attachment. Author (GRA)

N71-33409* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
SOLAR CELL Patent
Elmer R. Streed, inventor (to NASA) Issued 6 Jul. 1971 5 p Filed 6 Feb. 1969
(NASA-Case-ARC-10050; US-Patent-3,591,420; US-Patent-Appl-SN-797219; US-Patent-Class-136-89) Avail: US Patent Office CSCL 10A

A solar cell which utilizes phosphors in the cover glass which are excited to fluorescence by solar ultraviolet radiation and particulate radiation is described. The fluorescent energy passes through the interference filter for utilization in the solar cell, while the ultraviolet and other radiation would not normally be converted to electrical energy because the wavelength is not within the spectral response limits of the solar cell. Author

N71-34042*# Pennsylvania Univ., Philadelphia. Inst. for Direct Energy Conversion.
RESEARCH FOR THE IMPROVEMENT OF SILICON SOLAR CELL EFFICIENCY Status Report, 1 Jul. - 31 Dec. 1970
M. Wolf Jan. 1971 69 p refs
(Grant NGL-39-010-001)
(NASA-CR-121751; SR-17) Avail: NTIS CSCL 10A

The interrelationships between material and dimensional parameters in their influence on collection efficiency from both the base region and the diffused region were investigated. Some of the essential results were: (1) It is theoretically possible to collect over 99% of the minority carriers generated by photon absorption, even in thin solar cells. (2) A wide range of material and dimensional parameter combinations permits approaching the ideal case. (3) Until diffusion length in the diffused region can be better controlled than at present, improvement has to be accomplished through thickness reduction. (4) Reduction of surface recombination velocity will be a necessity. (5) Base region diffusion lengths, as achievable with present technologies, are sufficient from the collection efficiency viewpoint. (6) In the base region, the detrimental effect of the back contact can be neutralized by a drift field in front of the back contact. (7) Longer minority carrier lifetimes will be wanted. Author

N71-36441*# TRW Systems Group, Redondo Beach, Calif.
STUDY TO ESTABLISH CRITERIA FOR A SOLAR CELL ARRAY FOR USE AS A PRIMARY POWER SOURCE FOR A LUNAR-BASED WATER ELECTROLYSIS SYSTEM, PHASE 4 Final Technical Report, 15 Dec. 1970 - 15 Sep. 1971
J. E. Boretz and P. Goldsmith 15 Sep. 1971 54 p refs
(Contract NAS8-21189)
(NASA-CR-119945; TRW-09681-6008-R000) Avail: NTIS CSCL 10A

The prototype solar array panel was subjected to structural-dynamic, acoustic, and thermal vacuum cycling tests. In addition, electrical performance tests were conducted at the beginning and upon completion of the qualification test program. The design configuration is now considered technology-ready for future lunar surface applications. It has comparatively high specific power and is recommended for use in earth-orbital and planetary exploration programs where deployable, rigid panel solar arrays are required. E.M.C.

N72-13046*# Electro-Optical Systems, Inc., Pasadena, Calif.
DEVELOPMENT OF LIGHTWEIGHT ALUMINUM HOLLOWCORE SOLAR CELL ARRAY TECHNOLOGY
J. A. Carlson [1971] 103 p refs
(Contract NAS1-9495)
(NASA-CR-112002; FR-4045) Avail: NTIS CSCL 10A

A baseline configuration for a three section folding array, with retraction capability, was developed which would utilize electroformed aluminum hollowcore substrates and beryllium frames. The three section array was not fabricated because of difficulties with impurities in the aluminum electroforming bath. A procedure was developed for etching the copper mandrel from virtually any size of aluminum hollowcore panel in approximately one hour. Procedures were developed for analyzing the content of peroxide, water, total aluminum, and lithium-aluminum-hydride in an aluminum electroforming solution. Author

N72-13396*# Maryland Univ., College Park. Dept. of Mechanical Engineering.
RESPONSE CHARACTERISTICS OF A THERMAL-HELIOTROPE SOLAR-ARRAY ORIENTATION DEVICE c14
Frederick H. Morse *In* NASA. Goddard Space Flight Center 5th Aerospace Mech. Symp. 1971 p 33-39 refs (See N72-13391)
Avail: NTIS CSCL 14B

The thermal heliotrope is a passive solar-array orientation device containing a bimetallic helix that rotates when activated by solar energy. The rate and extent of the rotation depends upon the properties of the two metals and the temperature of the helix. An energy-balance analysis is performed to determine the temperature distribution in the helix. By initially restricting the analysis, a simplified equation governing the response of the heliotrope is obtained. In order to gain insight into the response of the heliotrope, a series of experiments were performed. The results of these tests and the implications are presented. Author

N72-14029*# Boeing Co., Seattle, Wash. Aerospace Group.
SIMULATED SPACE ENVIRONMENT TESTS ON CADMIUM SULFIDE SOLAR CELLS Final Report
David R. Clarke and Henry Oman [1971] 229 p refs
(Contract NAS3-11838)
(NASA-CR-120840; D180-12700-1) Avail: NTIS CSCL 10A

Cadmium sulfide (Cu2s - CdS) solar cells were tested under simulated space environmental conditions. Some cells were thermally cycled with illumination from a Xenon-arc solar simulator. A cycle was one hour of illumination followed immediately with one-half hour of darkness. In the light, the cells reached an equilibrium temperature of 60 C (333 K) and in the dark the cell temperature dropped to -120 C (153 K). Other cells were constantly illuminated with a Xenon-arc solar simulator. The equilibrium temperature of these cells was 55 C (328 K). The black vacuum chamber walls were cooled with liquid nitrogen to simulate a space heat sink. Chamber pressure was maintained at 0.000001 torr or less. Almost all of the solar cells tested degraded in power when exposed to a simulated space environment of either thermal cycling or constant illumination. The cells tested the longest were exposed to 10,050 thermal cycles. Author

N72-14032*# Scientific Translation Service, Santa Barbara, Calif.
EOLE BALLOON SOLAR GENERATORS
J. Bezaudun, ed. Washington NASA Dec. 1970 13 p Transl. of "Generateurs Solaires Eole-Balloons" Rept-70/CT/TA/EB/O. 671/Eole/B CNES, Centre Spatial de Toulouse. Div. Tech. Aerospatiales, Dept. Energie de Bord, Bretigny, 28 Sep. 1970 8 p
(Contract NASw-2035)
(NASA-TT-F-13836; Rept-70/CT/TA/EB/0.671/Eole/B) Avail: NTIS CSCL 10A

The results of qualification tests carried out with Eole balloon solar generator components are described. These include mechanical, electrical, environmental, and launch simulation tests. The components were found to be acceptable. Author

N72-19057*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
LARGE-SCALE TERRESTRIAL SOLAR CELL POWER GENERATION COST: A PRELIMINARY ASSESSMENT
Adolph E. Spakowski and Lloyd I. Shure Mar. 1972 13 p refs
(NASA-TM-X-2520; E-6675) Avail: NTIS CSCL 10A

A cost study was made to assess the potential of the large-scale use of solar cell power for terrestrial applications. The incentive is the attraction of a zero-pollution source of power for wide-scale use. Unlike many other concepts for low-pollution power generation, even thermal pollution is avoided since only the incident solar flux is utilized. To provide a basis for comparison and a perspective for evaluation, the pertinent technology was treated in two categories: current and optimistic. Factors considered were solar cells, array assembly, power conditioning, site preparation, buildings, maintenance, and operation. The capital investment was assumed to be amortized over 30 years. The useful life of the solar cell array was assumed to be 10 years, and the cases of zero and 50-percent performance degradation were considered. Land costs, taxes, and profits were not included in this study because it was found too difficult to provide good generalized estimates of these items. On the basis of the factors considered, it is shown that even for optimistic projections of technology, electric power from large-scale terrestrial use of solar cells is approximately two to three orders of magnitude more costly than current electric power generation from either fossil or nuclear fuel powerplants. For solar cell power generation to be a viable competitor on a cost basis, technological breakthroughs would be required in both solar cell and array fabrication and in site preparation. Author

N72-19066# Army Electronics Command, Fort Monmouth, N.J.
SOLAR CHARGER KIT EXPERIMENTAL
H. B. Seapker and J. W. Mount Nov. 1971 28 p
(DA Proj. 1S6-63719-DK-75)
(AD-734809; ECOM-3452) Avail: NTIS CSCL 10/2

The Solar Charger Kit was specifically developed to maintain the BB-501/U nickel-cadmium battery in service for the Integrated Observation System (IOS) AN/GVQ-10 when installed at remote observation post where no local power is available and supply replacements are frequently interdicted. The solar kit has broader application in any service wherever its output capacity is equal to the power demand. Author (GRA)

N72-21033*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
SOLAR ARRAY COST REDUCTION
D. T. Bernatowicz 1972 11 p Proposed for presentation at 25th Power Sources Symp., Atlantic City, 23-25 May 1972; Sponsored by USAMC
(NASA-TM-X-68035; E-6859) Avail: NTIS CSCL 10A

A brief description is given of the cost of solar power systems over the last decade and means by which cost reductions may be achieved in the future. Costs were broken down into nonrecurring and recurring costs for solar array, battery, and power conditioning. Correlation of costs with power were poor; however, costs correlated reasonably well with the array area. E.H.W.

N72-25022*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
COST STUDY OF SOLAR CELL SPACE POWER SYSTEMS
Daniel T. Bernatowicz 1972 4 p Presented at 9th Photovoltaic Specialists Conf., Silver Spring, Md., 2-4 May 1972; sponsored by IEEE
(NASA-TM-X-68054; E-6904) Avail: NTIS HC $3.00 CSCL 10A

Historical costs for solar cell space power systems were evaluated. The study covered thirteen missions that represented a broad cross section of flight projects over the past decade. Fully burdened costs in terms of 1971 dollars are presented for the system and the solar array. The costs correlate reasonably well with array area and do not increase in proportion to array area. The trends for array costs support the contention that solar cell and module standardization reduce costs. Author

N72-26034*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena. Guidance and Control Div.
CONSIDERATIONS WITH RESPECT TO THE DESIGN OF SOLAR PHOTOVOLTAIC POWER SYSTEMS FOR TERRESTRIAL APPLICATIONS
Paul A. Berman 15 Jun. 1972 16 p refs
(Contract NAS7-100)
(NASA-CR-127031; JPL-TR-32-1558) Avail: NTIS HC $3.00 CSCL 10A

The various factors involved in the development of solar photovoltaic power systems for terrestrial application are discussed. The discussion covers the tradeoffs, compromises, and optimization studies which must be performed in order to develop a viable terrestrial solar array system. It is concluded that the technology now exists for the fabrication of terrestrial solar arrays but that the economics are prohibitive. Various approaches to cost reduction are presented, and the general requirements for materials and processes to be used are delineated. Author

N72-27055*# National Academy of Sciences-National Research Council, Washington, D.C. Ad Hoc Panel on Solar Cell Efficiency.
SOLAR CELLS: OUTLOOK FOR IMPROVED EFFICIENCY
1972 78 p refs
(Contract NSR-09-012-903)
(NASA-CR-127234) Avail: NTIS HC $6.00 CSCL 10A

Studies are reported on the technical feasibility of increasing the efficiency of solar cells for use in space programs.

N72-27056* National Academy of Sciences-National Research Council, Washington, D.C.
THE PANEL'S REPORT
In its Solar Cells: Outlook for Improved Efficiency 1972 p 1-22 refs
CSCL 10A

The panel's considerations, conclusions, and recommendations for improving the efficiency of solar cells are summarized. Topics discussed include: benefits of increased solar cell efficiency, solar cell efficiency, and solar cell materials other than silicon. It is concluded that silicon solar cells offer the best opportunity for increased efficiency at lowest cost and shortest payoff time. F.O.S.

N72-27057* National Academy of Sciences-National Research Council, Washington, D.C.
AN INTRODUCTION TO THE PHYSICS OF SOLAR CELLS
Joseph J. Loferski *In its* Solar Cells: Outlook for Improved Efficiency 1972 p 25-49 refs
CSCL 10A

The physical processes underlying solar-energy conversion through the photovoltaic effect have been examined. The important roles played by bulk and surface recombination have been discussed. The relation between the basic material parameters and the current voltage characteristics of solar cells were reviewed. The maximum efficiencies for solar-energy conversion that can be expected for a number of semiconductors exceed the best values ever reported for any solar cell by a factor of at least 2. In the case of silicon, there is a considerable gap between the currently encountered 11 percent conversion efficiency and the 16 to 20 percent values predicted by analysis of the photovoltaic effect for that material. Author

N72-27059* National Academy of Sciences-National Research Council, Washington, D.C.
THE FUNDAMENTALS OF IMPROVED SILICON SOLAR-CELL PERFORMANCE
Martin J. Wolf *In its* Solar Cells: Outlook for Improved Efficiency 1972 p 56-70 refs
CSCL 10A

The loss mechanisms in present silicon solar cells were reexamined and their impact on conversion efficiency in air mass zero and air mass one sunlight analyzed. Attention was focused on the process-dependent losses that affect collection efficiency, voltage factor, and curve factor. The collection efficiency can be improved by 22 percent by reducing the surface recombination velocity for short-wavelength collection efficiency improvement and by increasing the minority carrier lifetime in thin cells to be combined with a drift field at the back contact for better collection in the long-wavelength range. Voltage factor and curve factor together can yield 56 percent efficiency improvement through reduction of base region resistivity, while maintaining the minority carrier lifetime near present values. Accomplishment of these changes should yield conversion efficiency values near 20 percent in air mass zero sunlight. Ideal conversion efficiencies were arrived at through thermodynamically based theories. Author

N72-29046# Army Foreign Science and Technology Center, Charlottesville, Va.
DOUBLE-MIRROR SOLAR ENERGY CONCENTRATORS USING NICKEL PARABOLIC REFLECTORS
G. Ya. Umarov, A. K. Alimov, Dzh. V. Alavutdinsov, and V. N. Zakirova 29 Jan. 1972 8 p refs Transl. into ENGLISH from Geliotekh., Atad. Nauk Uzb. SSR (USSR), no. 6, 1970
(AD-741880; FSTC-HT-23-1004-72) Avail: NTIS CSCL 20/6

A double-mirror system consisting of two concave mirrors significantly increases maximum flux density and the equilibrium temperature of an absolutely black body. One consisting of concave and convex parabolic mirrors has little decrease in maximum flux density and adjustment power, whereas the system's angle of opening is significantly decreased, improving efficiency of the device. Author (GRA)

N72-31077 Fabrica Italiana Apparecchi Radio S.p.A., Milan (Italy).
SOLAR ARRAY SIMULATOR
R. Formica *In* ESRO Spacecraft Power Conditioning Electron. Jul. 1972 p 309-314

Three possible design approaches for solar array simulators to be used during ground tests on satellite power systems conditioning electronic are described. The first two designs have already been manufactured and used: the first one in the development tests of the ELDO-PAS launcher and the Sirio satellite power system, and the second for testing the ESRO-4 power system. The third is a modification of the second. In the design the following major points have been considered: (1) simulation of the V/I characteristic as close as possible to the effective solar array characteristic; (2) full manual regulation of short-circuit current, open-circuit voltage and output resistance in the voltage mode operation; (3) modularity, in order to combine a certain number of solar array panels in series or paralleled to reach the required power levels; (4) dc and ac impedance as close as possible to the actual solar panels; and (5) capability of short-circuit current modulation to simulate eclipse input and output or boom shadows; this modulation is to be obtained by means of external signals (voltage or current). Author (ESRO)

N72-31083# Army Foreign Science and Technology Center, Charlottesville, Va.
SEMICONDUCTOR SOLAR ENERGY CONVERTERS AND THE PHENOMENON OF PHOTO CONDUCTIVITY QUENCHING
M. S. Isamukhamedora and P. M. Karageorgiy-Alkalayev 1 Feb. 1972 8 p refs Transl. into ENGLISH from Geliotekhnika. Akad. Nauk Uz. SSR (Tashkent), no. 3, 1970
(AD-743031; FSTC-HT-23-1577-71) Avail: NTIS CSCL 20/12

A semiconductor model with two impurity levels exchanging current carriers is analyzed to determine the conditions for the occurrence of photoconductivity quenching. The effects of this phenomenon on efficiency are described. Author (GRA)

N72-31092# National Academy of Sciences-National Research Council, Washington, D.C. Board on Science and Technology for International Development.
SOLAR ENERGY IN DEVELOPING COUNTRIES: PERSPEC-

TIVES AND PROSPECTS
Mar. 1972 60 p refs
(Contract AID/csd-2584)
(PB-208550; TA/OST-NAS-72-34) Avail: NTIS HC $4.50
CSCL 10A

This is a report of an ad hoc advisory panel, made up of specialists from the United States and abroad, to: (1) assess the state of the art in utilizing solar energy for developing countries and review current practical applications; (2) identify promising areas for research and development; and (3) examine the desirability of establishing an international solar energy institute in North Africa, to carry out solar energy research and development. GRA

N72-31637* Lockheed Missiles and Space Co., Sunnyvale, Calif.
SOLAR ENERGY POWERED HELIOTROPE Patent
Ralph Crawford, inventor (to NASA) Issued 25 Jul. 1972 6 p
Filed 25 Sep. 1970 Supersedes N71-28460 (09 - 16, p 2628)
Sponsored by NASA
(NASA-Case-GSC-10945-1; US-Patent-3,678,685;
US-Patent-Appl-SN-75431; US-Patent-Class-60-23;
US-Patent-Class-60-26) Avail: US Patent Office CSCL 17G

A solar energy powered heliotrope which functions in a passive, stored energy manner to orient a solar array toward the sun is discussed. A bimetallic motor element is activated by solar energy to generate a work output. A constant torque spring assembly coupled to the motor element stores useful energy as a function of the work output. A bimetallic sensing element detects misorientation between the solar array and the sun. An escapement mechanism is actuated by the sensing element whenever misorientation between the solar array and the sun is detected; the escapement mechanism automatically and incrementally releases the stored energy to rotate the solar array in discrete increments until it is oriented towards the sun.
Official Gazette of the U.S. Patent Office

N72-32070*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
THE DEVELOPMENT, DESIGN AND TEST OF A 66 W/kg (30-W/lb) ROLL-UP SOLAR ARRAY
W. A. Hasbach and R. G. Ross, Jr. 15 Sep. 1972 38 p refs
(Contract NAS7-100)
(NASA-CR-128196; JPL-TR-32-1562) Avail: NTIS HC $4.00
CSCL 10A

A program to develop a 250 square foot roll-up solar array with a power-to-weight ratio exceeding 30 watts per pound is described. The system design and fabrication of a full scale engineering development model are discussed. The system and development test program results are presented. Special test equipment and test procedures are included, together with comparisons of experimental and analytical results. Author

N72-33057*# Lockheed Missiles and Space Co., Sunnyvale, Calif. Space Systems Div. Power Systems.
EVALUATION OF SPACE STATION SOLAR ARRAY TECHNOLOGY First Topical Report Update
Jul. 1972 141 p refs
(Contract NAS9-11039)
(NASA-CR-128533; LMSC-A981486) Avail: NTIS HC $9.25
CSCL 10A

The research concerning lightweight solar array assemblies since 1970 is reported. A bibliography of abstracts of documents used for reference during this period is included along with an evaluation of available solar array technology. A list of recommended technology programs is presented. F.O.S.

N72-33061*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena. Guidance and Control Div.
PHOTOVOLTAIC SOLAR ARRAY TECHNOLOGY REQUIRED FOR THREE WIDE SCALE GENERATING SYSTEMS FOR TERRESTRIAL APPLICATIONS: ROOFTOP, SOLAR FARM, AND SATELLITE
Paul A. Berman 15 Oct. 1972 27 p refs
(Contract NAS7-100)
(NASA-CR-128381; JPL-TR-32-1573) Avail: NTIS HC $3.50
CSCL 10A

Three major options for wide-scale generation of photovoltaic energy for terrestrial use are considered: (1) rooftop array, (2) solar farm, and (3) satellite station. The rooftop array would use solar cell arrays on the roofs of residential or commercial buildings; the solar farm would consist of large ground-based arrays, probably in arid areas with high insolation; and the satellite station would consist of an orbiting solar array, many square kilometers in area. The technology advancement requirements necessary for each option are discussed, including cost reduction of solar cells and arrays, weight reduction, resistance to environmental factors, reliability, and fabrication capability, including the availability of raw materials. The majority of the technology advancement requirements are applicable to all three options, making possible a flexible basic approach regardless of the options that may eventually be chosen. No conclusions are drawn as to which option is most advantageous, since the feasibility of each option depends on the success achieved in the technology advancement requirements specified. Author

N73-10051*# National Aeronautics and Space Administration, Washington, D.C.
RELIABILITY ANALYSIS OF THE SOLAR GENERATOR OF THE ESRO 1 SATELLITE
Sep. 1972 24 p Transl. into ENGLISH of Soc. Anonyme de Telecommun. (Paris), no. 3015, 10 Nov. 1966 23 p
(NASA-TT-F-14498) Avail: NTIS HC $3.25 CSCL 10B

The reliability of the solar generator of ESRO 1 is studied by investigating the reliability of its components. The reliability is determined for the following components: diodes, solar cells, wiring, and panels. It is deduced that the reliability of the solar generator depends principally on the reliability of the diodes near the hottest walls. F.O.S.

N73-10976# Pennsylvania Univ., Philadelphia. Towne School of Civil and Mechanical Engineering.
CONSERVATION AND BETTER UTILIZATION OF ELECTRIC POWER BY MEANS OF THERMAL ENERGY STORAGE AND SOLAR HEATING Interim Report, 1 Feb. - 1 Jul. 1971
Manfred Altman 1 Oct. 1971 265 p refs
(Grant NSF GI-27976)
(PB-210359; UPTES-71-1) Avail: NTIS HC $6.75 CSCL 13A

A project to investigate the application of heat and coolness storage for comfort heating and air conditioning was initiated. Inexpensive salt hydrates exhibiting phase change temperatures between 40 F and 60 F were found appropriate with use of off-peak generation of coolness for storage and subsequent use during peak demand periods to supplement or replace electrically powered air conditioning units. Other inexpensive salt hydrates, with phase change temperatures of 89 F to 195 F were found for use as heat storage materials with solar heat collectors and off-peak electric heating units. A feasibility demonstration of the off-peak air conditioning system was built and successfully tested. Author (GRA)

N73-11050# Army Foreign Science and Technology Center, Charlottesville, Va.
CONTEMPORARY STATUS OF STUDIES ON DIRECT CONVERSION OF SOLAR ENERGY TO ELECTRICAL ENERGY
N. S. Lidorenko 28 Jul. 1972 11 p refs Transl. into ENGLISH from Geliotekhnika (Tashkent), no. 6, 1969 p 3-9
(AD-747293; FSTC-HT-23-1429-71) Avail: NTIS CSCL 10/2

Photoelectric, thermoelectric and thermoemission methods of direct conversion of solar energy into electric energy are studied. The article presents a review of modern methods of investigation. Author (GRA)

N73-12061# Los Alamos Scientific Lab., N.Mex.
LASER ACTIVATION OF SOLAR CELLS
Charles E. Backus 1972 11 p refs Presented at 9th IEEE

Photovoltaic Specialist Conf., Silver Spring, Md., May 1972 Sponsored by AEC
(LA-DC-72-468; Conf-720518-1) Avail: NTIS

A preliminary investigation was conducted on the feasibility of using photovoltaic cells to convert laser energy into electrical energy. The tests were made with readily available solar cells and lasers. When using the He-Ne Laser, the efficiencies of the silicon cells were improved by about 50% compared to operation in sunlight. The improvement in efficiency could have conceivably been increased to about 90% if an optimum wavelength laser were used. Efficiencies of GaAs cells also were improved about 50% but could perhaps have been increased to about 130% with an appropriate laser. Author

N73-13866* Florida Univ., Gainesville. Solar Energy and Energy Conversion Lab.
SOLAR ENERGY, ITS CONVERSION AND UTILIZATION
Erich A. Farber *In* NASA. Marshall Space Flight Center Space for Mankind's Benefit 1972 p 369-388

CSCL 10C

The work being carried out at the University of Florida Solar Energy and Energy Conversion Laboratory in converting solar energy, our only income, into other needed and useful forms of energy is described. A treatment such as this demonstrates, in proper perspective, how solar energy can benefit mankind with its many problems of shortages and pollution. Descriptions were given of the conversion processes, equipment, and performance. The testing of materials, solar water heating, space heating, cooking and baking, solar distillation, refrigeration and air-conditioning, work with the solar furnace, conversion to mechanical power, hot air engines, solar-heated sewage digestion, conversion to electricity, and other devices will be discussed. Author

N73-14812# Committee on Science and Astronautics (U. S. House).
SOLAR ENERGY RESEARCH. A MULTIDISCIPLINARY APPROACH
Philip B. Yeager Washington GPO 1973 120 p refs Presented by the Comm. on Sci. and Astronaut. at the 92d Congr., 2d Sess., 27 Dec. 1972
Avail: Comm. on Sci. and Astronaut.

Data, reported to the Committee on Science and Astronautics, on the current status and future potential of solar energy research are outlined. The information covers extent of need, who is doing the research and development, level of effort being extended, what the obstacles are - technological, economical, political and social, and the degree of reliance that can and should be placed in solar energy. Author

N73-15079*# General Electric Co., Philadelphia, Pa. Space Div.
FEASIBILITY STUDY OF A 110 WATT PER KILOGRAM LIGHTWEIGHT SOLAR ARRAY SYSTEM Quarterly Report, 1 Aug. - 31 Oct. 1972
N. F. Shepard, C. Stahle, A. Schneider, and K. L. Hanson 15 Nov. 1972 110 p refs Prepared for JPL
(Contracts NAS7-100; JPL-953387)
(NASA-CR-130287; QR-2; Doc-72SD4249) Avail: NTIS HC $7.50 CSCL 10A

An investigation of the feasibility of a solar array panel subsystem which will produce 10,000 watts of electrical output at 1 A.U. with an overall beginning-of-life power-to-weight ratio of at least 110 watt/kg is reported. A description of the current baseline configuration which meets these requirements is presented. A parametric analysis of the single boom, two blanket planar solar array system was performed to arrive at the optimum system aspect ratio. A novel concept for the stiffening of a lightweight solar array by canting the solar cell blankets at a small angle to take advantage of the inherent in-plane stiffness to increase the symmetric out-of-plane frequency is introduced along with a preliminary analysis of the stiffening effect. A comparison of welded and soldered solar cell interconnections leads to the conclusion that welding is required on this ultralightweight solar array. The use of a boron/aluminum composite material in a BI-STEM type deployable boom is investigated as a possible advancement in the state-of-the-art. Author

N73-15084# AEG-Telefunken, Hamburg (West Germany).
THE HELIOS SOLAR CELL GENERATOR [DER HELIOS-SOLARZELLEN-GENERATOR]
H. Duerre and B. Goergens 1972 24 p In GERMAN Presented at the 5th DGLR Ann. Meeting, Berlin, 4-6 Oct. 1972
(DGLR-Paper-72-091) Avail: NTIS HC $3.25

Design and performance of the solar array for the Helios solar probe are discussed. Each of the 32 solar cell panels contains 49% solar cells and 51% second surface mirrors. The temperature qualification range is from -95 C to +200 C. The power requirements range from 240 to 315 W for the complete generator. One of the optimization problems was the soldered contacts of the solar cells, for which a special solution was found. Each solar cell is protected from irradiation by 150 micron thick quartz glass. A series resistance of 0.165 ohms was obtained per cell by dimensional optimization. The design and construction of the solar generator is described. Tests have shown the space applicability of this design. Author (ESRO)

N73-15598*# Scientific Translation Service, Santa Barbara, Calif.
SELECTIVE SURFACES AND COATINGS IN SOLAR RADIATION ENGINEERING
M. M. Koltun Washington NASA Jan. 1973 23 p refs Transl. into ENGLISH from Geliotekh., Akad. Nauk Uzb. SSR (Uzbek SSR), no. 5, 1971 p 70-80
(Contract NASw-2483)
(NASA-TT-F-14650) Avail: NTIS HC $3.25 CSCL 11C

Literature covering selective coatings for semiconductor photo-converters, for solar energy converters using white-black surfaces, and for cooling systems using solar energy are reviewed. The achievements in this field are summarized as the construction of a theoretical basis for the development of selective surfaces for solar energy conversion, and the fabrication of selective coatings with nearly optimal optical properties for all types of solar energy conversion systems. Author

N73-17911*# Lockheed Missiles and Space Co., Huntsville, Ala. Research and Engineering Center.
THE DEVELOPMENT OF A RESIDENTIAL HEATING AND COOLING SYSTEM USING NASA DERIVED TECHNOLOGY
Mark J. ONeill, A. J. McDanal, and W. H. Sims Nov. 1972 99 p refs
(Contract NAS8-25986)
(NASA-CR-124063; LMSC/HREC-D306275; HREC-5986-3) Avail: NTIS HC $7.00 CSCL 20M

A study to determine the technical and economic feasibility of a solar-powered space heating, air-conditioning, and hot water heating system for residential applications is presented. The basic system utilizes a flat-plate solar collector to process incident solar radiation, a thermal energy storage system to store the collected energy for use during night and heavily overcast periods, and an absorption cycle heat pump for actually heating and cooling the residence. In addition, heat from the energy storage system is used to provide domestic hot water. The analyses of the three major components of the system (the solar collector, the energy storage system, and the heat pump package) are discussed and results are presented. The total system analysis is discussed in detail, including the technical performance of the solar-powered system and a cost comparison between the solar-powered system and a conventional system. The projected applicability of the system to different regions of the nation is described. Author

N73-19059*# Ohio State Univ., Columbus. Electronic Materials and Devices Lab.
EFFECTS OF POSITIVE ION IMPLANTATION INTO ANTI-

REFLECTION COATING OF SILICON SOLAR CELLS Final Report
A. E. Middleton, J. W. Harpster, W. J. Collis, and C. K. Kim 24 Jun. 1971 150 p refs Prepared for JPL
(Contracts NAS7-100; JPL-953042)
(NASA-CR-131090) Avail: NTIS HC $9.50 CSCL 10A

The state of technological development of Si solar cells for highest obtained efficiency and radiation resistance is summarized. The various theoretical analyses of Si solar cells are reviewed. It is shown that factors controlling blue response are carrier diffusion length, surface recombination, impurity concentration profile in surface region, high level of surface impurity concentration (degeneracy), reflection coefficient of oxide, and absorption coefficient of Si. The theory of ion implantation of charge into the oxide antireflection coating is developed and side effects are discussed. The experimental investigations were directed at determining whether the blue response of Si solar cells could be improved by phosphorus ion charges introduced into the oxide antireflection coating. Author

N73-20044*# Globe-Union, Inc., El Monte, Calif. Centralab Semiconductor Div.
DESIGN AND FABRICATION OF WRAPAROUND CONTACT SILICON SOLAR CELLS
G. Goodelle 5 Sep. 1972 32 p ref
(Contract NAS3-15345)
(NASA-CR-121003; Rept-6) Avail: NTIS HC $3.75 CSCL 10A

Work is reported on the development and production of 1,000 N+/P wraparound solar cells of two different design configurations: Design 1, a bar configuration wraparound and Design 2, a corner pad configuration wraparound. The project goal consisted of determining which of the two designs was better with regard to production cost where the typical cost of a conventional solar cell was considered as the norm. Emphasis was also placed on obtaining the highest possible output efficiency, although a minumum efficiency of 10.5% was required. Five hundred cells of Design 1 and 500 cells of Design 2 were fabricated. Design 1 which used similar procedures to those used in the fabrication of conventional cells, was the less expensive with a cost very close to that of a conventional cell. Design 2 was more expensive mainly because the more exotic process procedures used were less developed than those used for Design 1. However, Design 2 processing technology demonstrated a feasibility that should warrant future investigation toward improvement and refinement. Author

N73-20584 National Lending Library for Science and Technology, Boston Spa (England).
THE DAWN OF SOLAR METALLURGY
A. Presnyakov 14 Jul. 1972 3 p Transl. into ENGLISH from Pravda (Moscow), 14 Jul. 1972
(NLL-M-22830-(5828.4F)) Avail: Natl. Lending Library, Boston Spa, Engl.: 1 NLL photocopy coupon

A vacuum diffusion welding method for joining two different materials is described. The application of solar energy for metallurgical processes is analyzed. It is stated that solar energy can be used to heat any materials, to melt any metals, and to obtain sterile crystals from the metals. The design of a machine for diffusion welding of tubular samples of metal is reported. Author

N73-21712# Army Foreign Science and Technology Center, Charlottesville, Va.
FILM SOLAR ENERGY COLLECTOR WITH CONCENTRIC CIRCULAR SEAMS
A. Kh. Kamildzhanov 15 Jan. 1973 12 p refs Transl. into ENGLISH from Geliotekh. (USSR), no. 1, 1970
(AD-755829; FSTC-HT-23-1208-72) Avail: NTIS CSCL 13/1

At the present time, plastic films, covered on one side with a thin layer of aluminum, are used as solar energy concentrators in heliotechnology. Commercially produced film is insufficiently broad to obtain concentrators with large concavities. Therefore, in making concentrators with diameters larger than the film width, their surfaces are glued together from pieces. Thus, concentrators with parallel, radial and circular concentric seams are discussed. The results of experimental investigations of such concentrators was compared with data from investigations of concentrators without seams. Mirror diameters were identical, 0.5m in all variants of the tests, and the width and number of seams were not indicated. Author (GRA)

N73-21959# Royal Aircraft Establishment, Farnborough (England).
STATUS REPORT ON RAE ADVANCED SOLAR ARRAY DEVELOPMENT
F. C. Treble Jul. 1972 31 p refs Presented at the 9th IEEE Photovoltaic Specialists' Conf., Silver Spring, Md., 2-4 May 1972
(RAE-TR-72109; BR-29829) Avail: NTIS HC $3.75

Recent progress in advanced lightweight solar array technology is reviewed. Solar cell performance has been improved. Panel assemblies embodying a cementless mounting technique have successfully withstood prolonged deep thermal cycling and other environmental tests. Some are currently being flown experimentally on the Prospero technological satellite. A stowed array has survived severe vibration with negligible damage. A solution has been found to the problem of protecting the backs of the cells from low energy protons. Useful experience has been gained in all aspects of the manufacture, handling and testing of flexible folding arrays. Design qualification tests have begun on a 280W prototype. The advantages and disadvantages of this fold-up design in relation to the alternative roll-up type are discussed. Author (ESRO)

N73-21960# Army Foreign Science and Technology Center, Charlottesville, Va.
HETEROGENEOUS SOLAR CONVERTORS BASED ON POLYCRYSTALLINE CADMIUM SULFIDE AND GADMIUM SELENIDE
V. N. Komashchenko, A. I. Marchenko, and G. A. Fedorus 7 Sep. 1972 11 p refs Transl. into ENGLISH from Poluprov. Tekh. i Mikroelektron. (USSR), no. 4 p 112-121
(AD-756594; FSTC-HT-23-113-72) Avail: NTIS CSCL 20/12

The authors present data on the development and investigation of photoelectric convertors based on pressed sintered tablets of CdS and CdSe, plus somewhat more detailed data on photoelectric convertors based on CdSe films. GRA

N73-21973# Army Foreign Science and Technology Center, Charlottesville, Va.
SPACE ELECTRIC POWER PLANTS, PART 2
M. Korolev 7 Feb. 1973 7 p Transl. into ENGLISH from Pravda (Moscow), no. 161, 10 Jun. 1971 p 3
(AD-756039; FSTC-HT-23-921-72) Avail: NTIS CSCL 10/2

Solar batteries and power cells are discussed. 7,500 photocells comprising a panel 1 meter square generate more than 100 watts of electrical energy. Space service life of certain semiconductors is given as two to three years. Glass coatings protect panels from heavy protons. Reference is made to the Boeing Co. project of unfolding glass fabric panels for space use. Korolev also states that Soviet scientists confirm the feasibility of such a project but claim that it will be surpassed. Thin film highly efficient photocell panels have been developed in the USSR. Reference is made to an unspecified plant/factory which manufactures not only space power units (using solar energy) but ground solar power plants as well. A 600 watt pilot installation has been in operation in the Karakum desert. Author (GRA)

N73-22748*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
THE UTILIZATION OF SOLAR ENERGY TO HELP MEET OUR NATION'S ENERGY NEEDS
Ronald L. Thomas 1973 37 p refs Presented at Energy Crisis Symp., Albuquerque, 3-4 May 1973; sponsored by Natl.

Profess. Soc. of N. Mex.
(NASA-TM-X-68230; E-7439) Avail: NTIS HC $4.00 CSCL 10A

The nation's energy needs, domestic energy resources, and possible future energy resources are briefly discussed in this paper. Three potential solutions, coal, nuclear and solar are compared as to benefits and problems. The paper primarily discusses the options available in using solar energy as a natural energy resource. These options are discussed under the generation of electricity, heating and cooling of buildings, and the production of clean fuel. Author

N73-23015# Army Foreign Science and Technology Center, Charlottesville, Va.
PERFORMANCE RELIABILITY CALCULATION FOR A MODULAR SOLAR THERMOELECTRIC GENERATOR
Yu. N. Malevskii 10 Jan. 1973 9 p refs Transl. into ENGLISH from Geliotekhnika, Akad. Nauk Uz. SSR (Tashkent), no. 1, 1971 p 16-20
(AD-757087; FSTC-HT-23-1434-72) Avail: NTIS CSCL 10/2

Analysis is given of the overall reliability of a solar energy converter unit composed of thermoelectric modules, as a function of the reliability of individual photocells and component modules. Expressions are given to determine the reliability of various module circuit designs having the modules in series, parallel and combined connections. The usefulness of redundancy in these designs is noted. Suggestions are given concerning the selection of module circuit designs most suitable for given operational requirements. Author (GRA)

N73-25104# Army Foreign Science and Technology Center, Charlottesville, Va.
CALCULATION AND COST OPTIMIZATION OF CERTAIN SOLAR GENERATOR THERMOBATTERY PARAMETERS
L. M. Drabkin 12 Jan. 1973 12 p refs Transl. into ENGLISH from Geliotekhnika, Akad. Nauk Uz. SSR (Tashkent), no. 1, 1971 p 9-15
(AD-759812; FSTC-HT-23-1433-72) Avail: NTIS CSCL 10/2

A method for economic analysis of thermoelectric generators is discussed in the Russian report. A formula is presented which permits calculation of the cost of manufacture of a thermoelectric generator thermobattery (if material outlay on it is known). From the formula proposed, it follows in particular that, with a decrease in the weight of materials, the cost of a battery decreases linearly. However, with a decrease in the weight of materials (thickness of thermoelements), the number of thermoelements per watt generated grows, approaching infinity. Wage expenditures also increase considerably here. The formula does not take all factors into account, and it is impossible to build up a method for optimizing thermobattery construction parameter design, especially for the solar thermoelectric generator. (Author Modified Abstract) GRA

N73-26818*# Maryland Univ., College Park. Dept. of Mechanical Engineering.
AN ASSESSMENT OF SOLAR ENERGY AS A NATIONAL ENERGY RESOURCE
Paul Donovan, William Woodward, William E. Cherry, Frederick H. Morse, and Lloyd O. Herwig Dec. 1972 89 p refs Sponsored by NASA and NSF
(NASA-CR-133101) Avail: NTIS HC $6.50 CSCL 10A

The applications are discussed of solar energy for thermal energy for buildings; chemical and biological conversion of organic materials to liquid, solid, and gaseous fuels; and the generation of electricity. It is concluded that if solar development programs are successful, building heating for public use is possible within 5 years, building cooling in 6 to 10 years, synthetic fuels from organic materials in 5 to 8 years, and electricity production in 10 to 15 years. F.O.S.

N73-26976*# Scientific Translation Service, Santa Barbara, Calif.
LUMIDUC ARCHITECTURE
Guy Rottier Washington NASA 29 Jun. 1973 11 p Transl. into ENGLISH from the French report Bull-22
(Contract NASw-2483)
(NASA-TT-F-14963; Bull-22) Avail: NTIS HC $3.00 CSCL 13B

A new concept of architecture for urban design is discussed. The design enables solar rays to be captured and directed by means of reflection through channels to the interior of a dwelling, thereby foregoing the necessity of rooms having an outside exposure for solar illumination. Author

N73-30057*# Lockheed Missiles and Space Co., Sunnyvale, Calif.
SPACE STATION SOLAR ARRAY TECHNOLOGY EVALUATION PROGRAM Final Report
F. V. Bischof Feb. 1973 138 p
(Contract NAS9-11039)
(MSC-07163) Avail: NTIS HC $9.00 CSCL 10A

The results of all the major program phases of the program are reported. All goals of the program, which are listed were successfully accomplished and are briefly described. A complete list is included of all drawings generated during this program. Author

N73-30977*# Ion Physics Corp., Burlington, Mass.
DEVELOPMENT OF GALLIUM ARSENIDE SOLAR CELLS Final Report
Feb. 1973 43 p refs Sponsored by NASA, Prepared by JPL
(Contract JPL-953270)
(NASA-CR-135510) Avail: NTIS HC $4.25 CSCL 10A

The potential of ion implantation as a means of developing gallium arsenide solar cells with high efficiency performance was investigated. Computer calculations on gallium arsenide cell characteristics are presented to show the effects of surface recombination, junction space-charge recombination, and built-in fields produced by nonuniform doping of the surface region. The fabrication technology is summarized. Electrical and optical measurements on samples of solar cells are included. Author

N73-30982# Air Force Aero Propulsion Lab., Wright-Patterson AFB, Ohio.
LITHIUM-DOPED SILICON SOLAR CELLS STATE-OF-THE-ART Technical Report, Apr. - Oct. 1972
John M. Green Jun. 1973 43 p refs
(AF Proj. 3145)
(AD-764357; AFAPL-TR-73-4) Avail: NTIS CSCL 10/2

The present status of lithium-doped solar cells was investigated. Improvements in fabrication techniques have made possible lithium-doped cells which are 11.9% efficient at AMO conditions and 28 C. Cell areas of 12 square centimeters are now feasible. Annealing characteristics are highly temperature dependent with 60 C being the minimum array temperature for good performance. If the recovered power levels for N/P cells and P/N lithium-doped cells are compared for an array temperature of 80 C, it is found that the P/N lithium-doped cells are 15% higher after 10 to the 15th power/sq cm 1 Mev equivalent electrons and 85% higher after 10 to the 13th power/sq cm fission spectrum neutrons. Based on this survey the use of lithium-doped cells is recommended for missions which require solar arrays to operate at temperatures above 60 C, especially if the satellite must survive a nuclear weapon environment. Author (GRA)

N73-32655*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
FLAT-PLATE COLLECTOR PERFORMANCE EVALUATION. THE CASE FOR A SOLAR SIMULATION APPROACH
F. F. Simon and Paul Harlamert 1973 21 p refs Presented at Intern. Solar Energy Soc., Cleveland, 3-4 Oct. 1973
(NASA-TM-X-71427; E-7670) Avail: NTIS HC $3.25 CSCL 03B

A method is proposed for determining the performance of flat-plate solar collector using a simulated sun. Collector test variables that will help establish the basis for the indoor test facility at the Lewis Research Center are discussed. The use of the indoor testing should permit a standard test for the convenient and accurate determination of collector performance. Preliminary test results are reported as an example of the type of collector performance data to be expected from the simulation approach.
Author

N73-33007# Sandia Labs., Albuquerque, N.Mex.
ANALYSIS OF LINEAR FOCUSED COLLECTORS FOR SOLAR POWER
R. B. Pope and W. P. Schimmel, Jr. 1972 7 p refs Sponsored by AEC
(SLA-73-5319; Conf-730811-6) Avail: NTIS HC $3.00

The use of linear focused collectors to collect solar energy in a high-quality (high-temperature) state is analytically studied. The effects of variations in concentration, absorptance, and emittance of the receiver, silvering of the envelope, and system geometry are considered. Convective and radiative transport between the receiver and envelope and from the envelope to the environment are modeled. Radiative exchange processes are modeled with an approximate two-wavelength band model. Calculated results are presented for varying values of specular solar input, linear aperture, concentration, absorptance, emittance, collection temperatures, for both silvered and unsilvered envelopes, and for both evacuated and unevacuated cavities. The study indicates that collector extraction efficiencies of 40 to 60% can be reasonably expected. Highly selective surfaces are relatively unimportant for values of X greater than about 30 if the envelope is silvered. Collector efficiency is increased with increasing linear aperture. The studies indicate that efficient focused collectors providing highquality energy can probably be constructed with available technology.
NSA

N73-33011# Army Foreign Science and Technology Center, Charlottesville, Va.
SOLAR AND WIND POWER TO BE HARNESSED
Ya. Shefter, G. Aleksenko, N. Lidorenko, S. Iosipyan, and A. Shakhov 1 Nov. 1972 6 p Transl. into ENGLISH from Pravda (Moscow), 11 May 1971 p 3
(AD-765783; FSTC-HT-23-922-72) Avail: NTIS CSCL 10/2

The state-of-the-art of wind and solar power installations are discussed.
GRA

N73-33762# Cooperation Mediterraneenne pour l'Energie Solaire, Marseille (France).
MEDITERRANEAN COOPERATION FOR SOLAR ENERGY, BULLETIN NO. 22 [COOPERATION MEDITERRANEENNE POUR L'ENERGIE SOLAIRE, BULLETIN NO. 22]
Mar. 1972 91 p refs In FRENCH
(Bull-22) Avail: NTIS HC $6.75

Conference data on the use of solar energy in the Mediterranean are presented. Various techniques and equipment are also described.

N73-33763 Cooperation Mediterraneenne pour l'Energie Solaire, Marseille (France).
NEW HELIOTECHNIQUE [LA NOUVELLE HELIOTECHNIQUE]
M. Touchais *In its* Mediterranean Cooperation for Solar Energy, Bull. no. 22 Mar. 1972 p 5-7 In FRENCH

Utilization of solar energy on earth using an old and new heliotechnique is discussed. Data cover industrial applications and light and heat sources for homes. The economics of using solar energy is also examined.
Transl. by E.H.W.

N73-33767 Cooperation Mediterraneenne pour l'Energie Solaire, Marseille (France).
REFLECTIONS ON HELIOTHERMIC TRANSFORMATION OF DIRECT SOLAR RADIATION [REFLEXIONS SUR LA TRANSFORMATION HELIOTHERMIQUE SOUS RAYONNEMENT CONCENTRE]
A. Hima and D. Pailharey *In its* Mediterranean Cooperation for Solar Energy, Bull. no. 22 Mar. 1972 p 27-34 refs In FRENCH

Heliothermic transformation of solar electromagnetic radiation so that it can be used for heating purposes is discussed. Specifically, theories and formulas are proposed to aid in fabricating equipment to convert direct solar energy into heat for industrial use.
Transl. by E.H.W.

03 OTHER PRIMARY ENERGY SOURCES

Includes petroleum and oil, coal, shale, natural gas; nuclear fuel; wind power, geothermal energy, remote sensing of energy resources.

A68-21940 #
ECOLOGICAL SIGNIFICANCE OF WASTE HEAT UTILIZATION.
Alfred A. Bacher (Department of the Interior, Office of Saline Water, Washington, D.C.) and Samuel A. Zwickler (Burns and Roe, Inc., New York, N.Y.).
IN: ECOLOGICAL TECHNOLOGY: SPACE-EARTH-SEA. VOLUME 1 - TECHNOLOGICAL TRANSFERENCE SYMPOSIUM, 1ST, SMITHSONIAN INSTITUTION, WASHINGTON, D.C., FEBRUARY 14, 15, 1966, PROCEEDINGS.
Symposium sponsored by the National Cybernetics Foundation. Edited by E. B. Konecci.
Austin, Tex., University of Texas (Transference of Technology Series No. 1), 1967, p. 197-221.
Discussion of actual and planned methods for the utilization of waste heat generated by the combustion of rubbish and by industrial furnaces, electrical fixtures, and human beings. Some of the uses to which this surplus heat could be put include the distillation of sea water and the heating of industrial buildings. R.B.S.

A68-23286 *
NUCLEI OF PLEOCHROIC HALOS IN BIOTITES OF SOME SIERRA NEVADA GRANITIC ROCKS.
Kenneth G. Snetsinger (NASA, Ames Research Center, Space Sciences Div., Moffett Field, Calif.).
American Mineralogist, vol. 52, Nov.-Dec. 1967, p. 1902, 1903. 13 refs.
Study of the halos in some Sierra Nevada granites in order to obtain data regarding the nuclei in the biotite of these rocks. The relationship between the zircon content of the biotites and the production of halos in these structures is investigated. R.B.S.

A68-27231 *
ANALYSIS OF THE MINERAL ENTRAPPED FATTY ACIDS ISOLATED FROM THE GREEN RIVER FORMATION.
A. L. Burlingame and B. R. Simoneit (California, University, Dept. of Chemistry and Space Sciences Laboratory, Berkeley, Calif.).
Nature, vol. 218, Apr. 20, 1968, p. 252-256. 21 refs.
NASA-supported research.
Analysis of the organic acids liberated after demineralization of the exhaustively extracted oil shale of the Green River Formation. The families of acidic components which were found were the same as those reported in the solvent soluble fraction of the oil shale by Haug et al. (1967, 1968). The relative concentrations differed widely, however, and some distributions within homologous series varied, probably as a result of solubility properties in their isolation. M.F.

A68-30437
PUT GEOLOGY SURVEYS IN ORBIT TO FIND OIL.
Frank J. Wobber (International Business Machines Corp., Federal Systems Div., Space Systems Center, Bethesda, Md.).
Oil and Gas Journal, Dec. 11, 1967. 5 p.
Suggestion that Gemini photographs offer some insight to the use of space photography as a tool for the petroleum industry, and especially for geologists involved in regional mapping or modern environmental research. The advantages of orbital surveys are the collection of synoptic worldwide data and the opportunity for reconnaissance mapping without political-boundary restrictions. A closer examination of cloud-free Gemini photographs obtained over low-latitude deserts in North Africa and the Mideast shows that sand provenance areas, aeolian processes, and topographical factors related to dune migration and orientation can be speedily detected, leading to a deeper understanding of the origin, developments, and changing morphology of desert dunes. P.v.T.

A68-33439
THE POTENTIAL OF METHANE AS A FUEL FOR ADVANCED AIRCRAFT.
C. L. Joslin (United Aircraft Corp., Pratt and Whitney Aircraft Div., Florida Research and Development Center, West Palm Beach, Fla.).
IN: AVIATION AND SPACE: PROGRESS AND PROSPECTS; PROCEEDINGS OF THE ANNUAL AVIATION AND SPACE CONFERENCE, BEVERLY HILLS, CALIF., JUNE 16-19, 1968.
New York, American Society of Mechanical Engineers, 1968, p. 351-355.
Discussion of the potential benefits of methane as a fuel for advanced aircraft, and comparison of methane and standard JP fuels as to performance, economy, combustion and heat transfer, and handling. Benefits associated with the use of methane include greater availability, lower cost, reduced IR signature, elimination of smoke, increased engine life, improved specific fuel consumption, and better engine power-to-weight ratio. Safety aspects and foreseeable problem areas associated with the use of methane are also discussed. M.G.

A68-35741
GAS TURBINE FUELS.
Herbert R. Hazard.
IN: GAS TURBINE ENGINEERING HANDBOOK (1st Edition).
Edited by J. W. Sawyer.
Stamford, Conn., Gas Turbine Publications, Inc., 1966, p. 172-182. 10 refs.
Evaluation of gas-turbine fuels, emphasizing the difference between aircraft fuels and industrial fuel requirements. Aircraft fuels have properties which have been selected and compromised to provide excellent long-term storage, characteristics suitable for pumping, filtration, metering, and atomization at high altitudes and low ambient temperatures, good combustion characteristics, and availability in substantial quantities at moderate cost. They differ from commercial diesel or burner fuels in having lower freezing points, lower aromatic content, and special luminosity characteristics. Fuels for industrial gas turbines are selected almost entirely on the basis of economics. In order of importance, the most common fuels are natural gas, petroleum distillates, refinery and chemical-plant gases and liquids, and residual fuel oil. Efforts to develop a commercial specification for a low-sodium residual fuel oil for gas-turbine use are now in progress. P.v.T.

A68-41768
THE LUBRICITY CHARACTERISTICS OF HEAVY AROMATICS.
J. K. Appeldoorn and F. F. Tao (Esso Research and Engineering Co., Linden, N.J.).
Wear, vol. 12, Aug. 1968, p. 117-130. 5 refs.
USAF-supported research.
Discussion of the influence of heavy aromatics on the lubricity of petroleum oils. Heavy aromatic hydrocarbons are the most probable cause of the good lubricating characteristics of petroleum oils. As little as 2% can greatly reduce wear and friction and increase the load-carrying capacity of paraffins. These mixtures of heavy aromatics and paraffins are much better than either component alone. Condensed-ring heavy aromatics have a second unusual behavior: in the absence of water and oxygen they will scuff at very low loads. The unusual behavior of the heavy aromatics is attributed to a little-understood decomposition reaction at the rubbing surface and not to oxidation or reaction with the metal. Z.W.

A68-43667
POWER GENERATION FOR AIRCRAFT IN THE SECOND CENTURY.
M. W. Thring (London, University, Queen Mary College, London, England).
Aeronautical Journal, vol. 72, Sept. 1968, p. 735-738. 9 refs.
Consideration of power generation for civilian aircraft in terms of what kind of flying people will want to do in the second century of powered flight. The predictable primary power sources are fossil chemical fuels, nuclear fuels, and solar energy. Future transport possibilities are outlined. These include air-cushion vehicles, a helium-filled airship, overhead monorails, and various types of

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winged aircraft. It is considered that portable hydrocarbon fuels will be available for all the transport needs for perhaps fifty years. Attention is given to possible developments in chemical fuels, and to advanced power systems. F. R. L.

A68-44446 *#

A REVIEW OF THE POTENTIAL OF LIQUID-METHANE FUEL FOR SUPERSONIC TRANSPORTS.

Richard J. Weber (NASA, Lewis Research Center, Mission Analysis Branch, Cleveland, Ohio).

National Academy of Sciences, Cryogenic Engineering Conference, Cleveland, Ohio, Aug. 19-21, 1968, Paper. 16 p. 9 refs.

Review of the potential of liquid methane as a fuel for supersonic aircraft by comparing it with conventional kerosene. The use of methane rather than kerosene is discussed in terms of engine performance and aircraft design. It is pointed out that the current demand to limit engine noise tends to nullify the utility of methane's superior cooling capacity. Substitution of liquid methane fuel for conventional kerosene promises reductions in direct operating cost of 30% or more. The disadvantages of liquid methane are its low density and low boiling point. The importance of minimizing boiloff is emphasized, and techniques for treating the problem of pressure-induced boiloff are studied. M. F. J.

A68-44975 #

ACTIVE COOLING OF A HYDROGEN FUELED SCRAMJET ENGINE.

L. L. Pagel and W. R. Warmbold (McDonnell Douglas Corp., McDonnell Aircraft Co., St. Louis, Mo.).

American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 5th, Philadelphia, Pa., Oct. 21-24, 1968, Paper 68-1091. 9 p.

Members, $1.00; nonmembers, $1.50.

Analytical studies were performed to determine engine cooling requirements for a scramjet powered, high-altitude cruise aircraft. A comparison of active cooling concepts resulted in the selection of a regenerative system using superalloy heat exchangers and the hydrogen fuel as coolant. This approach resulted in efficient operation (i.e., equivalence ratios of less than one) at flight speeds of Mach 12 or greater. Internal aerodynamic heating rates were predicted by the reference enthalpy turbulent heating correlation and increased locally to account for shock/boundary layer interaction effects. Coolant side heat transfer analyses were performed to determine near optimum heat exchanger core geometry. Sensitivity studies established the relationship between engine cooling requirements and key parameters for a representative aircraft. (Author)

A68-45023 #

ENDOTHERMIC FUELS FOR HYPERSONIC VEHICLES.

H. Lander (USAF, Systems Command, Research and Technology Div., Aero Propulsion Laboratory, Support Technology Div., Fuels, Lubrication and Hazards Branch, Wright-Patterson AFB, Ohio) and A. C. Nixon (Shell Oil Co., Shell Development Co., Chemical Engineering Dept., Emeryville, Calif.).

American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 5th, Philadelphia, Pa., Oct. 21-24, 1968, Paper 68-997. 13 p. 15 refs.

Members, $1.00; nonmembers, $1.50.

USAF-sponsored research.

Study of the use of hydrocarbon fuels for cooling in hypersonic vehicles. In order to achieve maximum heat sinks, endothermic reactions must be employed to augment fuel enthalpy. These reactions include thermal cracking, depolymerization, dehydrogenation, and dehydrocyclization. Of these the catalytic dehydrogenetion of naphthenes shows the most promise for practical application. The dehydrogenation of MCH over a Pt/Al_2O_3 catalyst can approximately double the 1000 Btu/lb available from fuel enthalpy. This should provide cooling sufficient to allow flight into the range of Mach 10 at optimum altitude. Factors which are important in this consideration such as thermal stability, reaction range, reactor weight and volume heat transfer, pressure drop, combustion characteristics, and the mating of the cooling system to the aircraft are discussed. Research directions to be pursued in future studies are indicated. P. v. T.

A69-19456 #

EFFECT OF SULFIDES CONTAINED IN FUELS ON THEIR OPERATIONAL PROPERTIES [VLIIANIE SUL'FIDOV, SODERZHASHCHIKHSIA V TOPLIVAKH, NA IKH EKSPLUATATSIONNYE SVOISTVA].

Ia. B. Chertkov, V. G. Spirkin, and S. G. Klimov.

Khimiia i Tekhnologiia Topliv i Masel, vol. 14, no. 1, 1969, p. 50-53. In Russian.

Study of the effect of petroleum sulfides present in distillates with intermediate boiling points on the oxygen consumption during combustion. It is found that petroleum sulfides are effective antioxidizers with respect to these fuels. Since they act as natural inhibitors, their presence should be regarded as advantageous. The effect of petroleum sulfides should be considered after solving the problem of decontamination of distillates from sulfur compounds. Z. W.

A69-23975

AN IMPROVED VISCOSITY-TEMPERATURE CHART FOR HYDROCARBONS.

W. A. Wright (Sun Oil Co., Marcus Hook, Pa.).

Journal of Materials, vol. 4, Mar. 1969, p. 19-27. 14 refs.

A new viscosity-temperature chart for hydrocarbons is presented. It has greatly improved linearity and useful range as compared to the present ASTM Designation D 341 and others which have been proposed from time to time. The new mathematical expression has been derived empirically from current data on both pure hydrocarbons and petroleum fractions. It is demonstrated that the improved chart will permit reliable linear extrapolations into low-viscosity, high-temperature regions which were not possible previously. (Author)

A69-33265 #

ANALYTICAL STUDY OF CATALYTIC REACTORS WHICH PROMOTE ENDOTHERMIC REACTIONS OF HYDROCARBON FUELS.

Arthur S. Kesten (United Aircraft Corp., United Aircraft Research Laboratories, East Hartford, Conn.).

American Institute of Aeronautics and Astronautics, Thermophysics Conference, 4th, San Francisco, Calif., June 16-18, 1969, Paper 69-588. 7 p. 9 refs.

Members, $1.00; nonmembers, $1.50.

Experimental demonstration of the cooling capabilities of catalytic reactors which promote endothermic reactions of hydrocarbon fuels, using the dehydrogenation of methylcyclohexane (MCH) fuel over a platinum on alumina catalyst. A computer program has also been formulated to describe the steady-state behavior of these packed-bed reactors by computing temperature and composition profiles in a homogeneous mixture of vapor and catalyst particles. A more comprehensive theoretical analysis, previously developed to describe the behavior of adiabatic, constant-pressure packed-bed reactors, was modified for application to the MCH system. This analysis considers the effects of heat and mass diffusion on reaction rates in porous catalyst particles. The effects of catalyst pore size on temperature and fractional MCH conversion profiles are illustrated for various operating temperatures. M. M.

A69-38458

THERMOELECTRIC GENERATORS HEATED BY RADIOISOTOPES (LES GENERATEURS THERMOELECTRIQUES CHAUFFES AUX RADIOISOTOPES).

Michel Alais (Société Alsacienne de Constructions Atomiques, de Télécommunications et d'Electronique, Paris, France).

Entropie, May-June 1969, p. 21-27. In French.

Description of the Gisete 5, an electrically heated, radioisotopic generator for submarine use, at depths of 200 m. The 15-W generator uses a source of 80,000 curies of strontium 90. Criteria for the choice of the isotropic source are presented, and a table giving the characteristics of a number of radio elements suitable for use as a power source for generators is included. The choice of a charge of strontium 90 is based on its availability as a product of uranium fission and its insolubility under water. In addition, it represents the best compromise of all the elements considered, in terms of periodicity and specific power. A test is reported showing that a slight augmentation of the power source makes it possible to achieve 20 W of electricity at 24 V. B.H.

A69-43142

RANGE AND FLIGHT ECONOMY OF POWER GLIDERS (REICHWEITE UND FLUGÖKONOMIE VON MOTORSEGLERN).
Nils Hiorth.
Deutscher Aerokurier, vol. 13, Sept. 1969, p. 602, 603. In German.

Derivation of formulas for calculating the flight range and fuel consumption of power gliders when used for transportation rather than competitive purposes. Applying these formulas to a suitable example, the calculations show that power gliders are appreciably more economical than automobiles. V.P.

A70-12516 *

APPLICATION OF GAS CHROMATOGRAPHY AND MASS SPECTROMETRY TO PORPHYRIN MICROANALYSIS—A STUDY OF HOMOLOGOUS PORPHYRIN SERIES IN ANCIENT BIOLOGICAL RESIDUES.
David B. Boylan, Yousif I. Alturki, and Geoffrey Eglinton (Bristol, University, School of Chemistry, Organic Geochemistry Unit, Bristol, England).
IN: ADVANCES IN ORGANIC GEOCHEMISTRY FOR 1968.
Edited by P. A. Shenk and I. Havenaar.
Braunschweig, F. Vieweg, 1969, p. 227-239; Discussion, W. G. Meinschein, A. L. Burlingame, E. V. Whitehead, and W. Heller, p. 239, 240. 6 refs.
Grant No. NGL-05-003-003.

Recent advances have concerned the conversion of porphyrin pigments to volatile bis (trimethylsiloxy) silicon complexes that can be gas chromatographed under normal conditions. These techniques have been applied to the analysis of homologous series of porphyrins such as are found in recent and ancient sediments and oils. Gas chromatographic and mass spectrometric analysis of GC fractions of the Boscan petroporphyrins are discussed and compared with results obtained from a preliminary analysis of Green River shale porphyrins. (Author)

A70-25897 **Bureau of Mines—API survey of aviation gasolines, 1969.** C. M. McKinney and O. C. Blade (U.S. Bureau of Mines, Washington, D.C.). *Society of Automotive Engineers, National Business Aircraft Meeting, Wichita, Kan., Mar. 18-20, 1970, Paper 700228.* 7 p. Members, $1.00; nonmembers, $1.50.

Tabulation of the inspection data for 67 samples of three grades (80/87, 100/130, and 115/145) of commercial aviation gasolines produced in the United States during 1969. The results are compared with similar data for gasolines produced during 1964, the last year for which such data are available, and with recently revised specification requirements of the ASTM. Z.W.

A70-29999 **Aviation fuels and lubricants (Flugkraftstoffe und Flugschmierstoffe).** Günter Spengler (München, Technische Hochschule; Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Flugtreib- und Schmierstoffe; Landesgewerbeanstalt Bayern, Munich, West Germany) and Heinz Beck (Zentralstelle für Luftfahrtdokumentation und -information, Munich, West Germany). *VDI-Z,* vol. 112, no. 9, 1970, p. 584, 585. 35 refs. In German.

Review of present and expected future trends in aviation fuels and lubricants. The stringent requirements of SST aircraft and the changes in fuels and lubricants designed to meet the new needs are discussed, along with fire-hazard and pollution minimization measures. M.V.E.

A70-36657 # **Employment of LPG as fuel in a fuel cell (Sull'impiego del GPL come combustibile in una fuel-cell).** Giancarlo Ferrari (CNR, Rome, Italy). *Istituto Internazionale delle Comunicazioni, Convegno Internazionale delle Comunicazioni, 17th, Genoa, Italy, Oct. 8-12, 1969, Paper.* 25 p. 10 refs. In Italian.

Investigation of the possibility of using LPG as a fuel cell fuel for powering both civil and military vehicles, for marine propulsion, and for the implementation of transportable power generators for manifold applications. It is shown that a specific system using LPG as a fuel cell fuel is definitely competitive from the efficiency standpoint with conventional power generators compared to which, however, it has a greater weight and overall dimensions. M.M.

A70-43439 # **Gas turbine cycle calculations - The effects of fuel composition and heat of combustion.** T. A. P. S. AppaRao and E. P. Cockshutt (National Research Council, Ottawa, Canada). *CASI Transactions,* vol. 3, Sept. 1970, p. 162-169. 10 refs.

A procedure has been developed for the calculation of gas turbine cycles using a general hydrocarbon as the fuel. Computer programs have been developed to facilitate the calculations, by suitably modifying existing ones previously developed at the National Research Council, Ottawa. Using these programs, the effects of changes in the fuel composition and heat of combustion on the performance of typical turbojet, turbofan, turboprop and turboshaft cycles were studied. The performance of different fuels was compared with Standard Fuel performance. It is shown that thermal efficiency is a better performance criterion than specific fuel consumption, if fuel composition is a significant variable in cycle studies. Thermal efficiency and specific power may in many cases be computed with Standard Fuel without significant loss of accuracy; this applies for fuels with H/C ratios lying between 1.8 and 2.05 (or heating values between 10,200 CHU/lb. and 10,450 CHU/lb.) and thus embraces all common aircraft fuels plus many vehicular and industrial fuels. (Author)

A71-17433 # **Chemical stabilization of engine and jet fuels (Khimicheskaia stabilizatsiia motornykh i reaktivnykh topliv).** M. F. Vol'f. Moscow, Izdatel'stvo Khimiia, 1970. 373 p. 620 refs. In Russian.

Problems associated with the chemical stabilization automobile and aircraft ethylated gasolines and jet and diesel fuels during storage, transportation, and utilization are discussed. Domestic and foreign experience in improving fuel stabilization by such additions as antioxidizing and dispersing agents and deactivators of metals is reviewed. Techniques used for introducing chemical additions to the fuels are examined, together with accepted methods of testing and evaluating the stability of gasolines and jet and diesel fuels. The book is intended for scientists and engineers employed in the petroleum industry, and for individuals specializing in storing fuels. V.P.

A71-24239 **Development of a single-grade general aviation avgas.** H. J. Foster and L. G. Olson (Shell Oil Co., Houston, Tex.). *Society of Automotive Engineers, National Business Aircraft Meeting, Wichita, Kan., Mar. 24-26, 1971, Paper 710369.* 14 p. Members, $1.00; nonmembers, $1.50.

To verify the practicality of a single-grade general aviation avgas which would meet the needs of engines using grade 80/87 and 100/130 fuel, a flight evaluation was conducted in selected light aircraft. Some 2200 hr of actual flight operation demonstrated the acceptability of this fuel for grade 80/87 certificated aircraft, together with a performance advantage for grade 100/130 users. (Author)

A71-24852 # **Endothermic fuels for hypersonic vehicles.** H. Lander (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio) and A. C. Nixon (Shell Development Co., Emeryville, Calif.). *(American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 5th, Philadelphia, Pa., Oct. 21-24, 1968, Paper 68-997.) Journal of Aircraft,* vol. 8, Apr. 1971, p. 200-207. 15 refs. USAF-sponsored research.

Study of the use of hydrocarbon fuels for cooling in hypersonic vehicles. In order to achieve maximum heat sinks, endothermic reactions must be employed to augment fuel enthalpy. These reactions include thermal cracking, depolymerization, dehydrogenation, and dehydrocyclization. Of these the catalytic dehydrogenation of naphthenes shows the most promise for practical application. The dehydrogenation of MCH over a Pt/Al_2O_3 catalyst can approximately double the 1000 Btu/lb available from fuel enthalpy. This should provide cooling sufficient to allow flight into the range of Mach 10 at optimum altitude. Factors which are important in this consideration such as thermal stability, reaction range, reactor weight and volume, heat transfer, pressure drop, combustion characteristics, and the mating of the cooling system to the aircraft are discussed. Research directions to be pursued in future studies are indicated. P.v.T.

A71-28754 **Fuels for aircraft gas turbine engines.** A. Lewis (Shell Research, Ltd., Thornton Research Centre, Chester, England). In: Combustion and heat transfer in gas turbine systems; Proceedings of an International Propulsion Symposium, College of Aeronautics, Cranfield, Beds., England, April 15-17, 1969. Edited by E. R. Norster. Oxford, Pergamon Press, Ltd. (Cranfield International Symposium Series. Volume 11), 1971, p. 309-323; Discussion, p. 324, 325. 11 refs.

Consideration of kerosene-type fuels meeting either the British D.Eng.R.D.2494 specifications or the ASTM Jet A or A-1 specifications. These fuels are produced mainly by straightforward distillation processes, with subsequent treatments to remove sulfur and trace components. Combustion problems with either type of fuel have been largely eliminated by the progressive development of the engines although there is a growing preoccupation with the formation and emission of smoke during takeoff and landing. The trend of fuel injection systems is towards greater use of air assistance in atomization and the possible use of fuel vaporization. The possibility of fuel additives for reducing smoke emission is discussed. The problems of bacterial or fungal contamination of aircraft fuel systems still exist. F.R.L.

A71-33291 **Bayesian decision theory - Promise and problems.** Arthur M. Breipohl (Kansas, University, Lawrence, Kan.). In: Annals of reliability and maintainability. Volume 10 - Assurance technology relates to today's world; Proceedings of the Tenth Reliability and Maintainability Conference, Anaheim, Calif., June 27-30, 1971. Conference sponsored by the American Society of Mechanical Engineers, the Society of Automotive Engineers, and the American Institute of Aeronautics and Astronautics. New York, American Society of Mechanical Engineers, 1971, p. 49-52. 7 refs.

Elementary examples with gross abstractions of real problems are treated to assess the qualities of the Bayesian decision theory in treating decision problems. The constituents of a decision problem are displayed in discussing the choice of three possible systems to convert wind into electrical energy. The current power vs pollution problem is abstracted into a decision theory context to illustrate some of the difficulties involved in the decision theory. V.Z.

A71-38076 * **Combustion Institute, Symposium (International) on Combustion, 13th, University of Utah, Salt Lake City, Utah, August 23-29, 1970, Proceedings.** Symposium supported by the National Science Foundation, NSF Grant No. K-016286; the U.S. Air Force, Contract No. AF 44(620)-70-C-0075; the U.S. Navy, Contract No. N 00014-70-C-0075; NASA, Contract No. NSR-39-003-008; and the U.S. Army, Grant No. DA-ARO(D)-31-124-70-685. Pittsburgh, Combustion Institute, 1971. 1126 p. Members, $25.; nonmembers, $48.

Combustion and fundamental flame phenomena served as one major theme, while the applications of combustion, with particular emphasis on fire hazards and pollution, served as the second. This combination of topics emphasized the challenge of providing the methods necessary to achieve maximum utilization of fuel resources with minimum contamination and modification of the environment. The fields covered were the kinetics of elementary chemical reactions; chemical kinetics in shock tubes; low-temperature oxidation of hydrocarbons; chemi-ionization and electrical properties of flames; air pollution; engine combustion and emissions; oscillatory combustion; laminar and turbulent flame propagation; flame structure and flames involving halogens; ignition; liquid and vapor diffusion flames; metal particle combustion; combustion of solid organic materials; fire spread; solid-propellant combustion; and detonation. Comprehensive author and subject indexes are provided. F.R.L.

A71-38948 * **Radioisotopes: Famine or feast - A review of availability.** James C. Graf and Paul E. Brown (General Electric Co., Space Div., Philadelphia, Pa.). In: Society of Automotive Engineers, Intersociety Energy Conversion Engineering Conference, Boston, Mass., August 3-5, 1971, Proceedings. Conference co-sponsored by the American Chemical Society, the American Institute of Aeronautics and Astronautics, the American Society of Mechanical Engineers, the Institute of Electrical and Electronics Engineers, the American Institute of Chemical Engineers, and the American Nuclear Society. New York, Society of Automotive Engineers, Inc., 1971, p. 918-932. 28 refs. Contract No. NAS 9-11343.

To be of use as an energy source in power conversion systems, a radioisotope must be available in the quantity and form required for the application. Although the AEC currently remains the major source of radioisotopes for conversion systems, the proliferation of commercial nuclear power reactors in the next 10 years will generate large quantities of fission products and transuranium elements as by-products of operation which can potentially be recovered and used. The nuclear and radiation properties of these nuclides, and the thermal characteristics of the most probable chemical form of each are briefly described, together with the limitations on usefulness imposed by specific power, half-life, and other factors. The projected availability of a number of these isotopes and their possible costs are assessed. M.M.

A72-15743 # **Determination of heat losses in an oil well during the injection of a hot liquid in the stratum (Sur la détermination des pertes de chaleur dans un puits de pétrole pendant l'injection d'un liquide chaud dans le gisement).** T. Oroveanu (Institut de Pétrole, Ploieşti, Rumania). *Revue Roumaine des Sciences Techniques, Série de Mécanique Appliquée,* vol. 16, no. 6, 1971, p. 1193-1206. 5 refs. In French.

This investigation was made during the injection of a heated liquid into the layer. Such a process is used to enhance the effectiveness of the oil displacement toward the extraction well. The formulas known in the specialized literature which allow the calculation of these losses are deduced starting from very elementary considerations with the aim of establishing a more rigorous computation process. An attempt in this respect was made by Oroveanu (1971) by averaging certain approximations imposed by the complexity of the problem and by the necessity of finding a very simple solution. By forgoing one of these approximations and partially modifying the hypothesis, a more exact solution is obtained. M.M.

A72-16600 **Oil slick remote sensing.** J. T. Smith, Jr. (NOAA, National Ocean Survey, Rockville, Md.). *Photogrammetric Engineering,* vol. 37, Dec. 1971, p. 1243-1248.

An oil spill off Cape Hatteras, North Carolina, resulting from the sinking of a tanker, was located and photographed by the National Ocean Survey using its Buffalo photographic aircraft equipped with two aerial cameras and a thermal-IR scanner. The spill was found about 80 nautical miles east-southeast from the reported position of the sinking of the stern section. Probable reasons explaining this phenomenon were examined. It was speculated that the bow of the ship had been carried by ocean currents to its eventual location where it sank and released its cargo of oil. O.H.

A72-22406 **Fabrication and irradiation behavior of uranium mononitride.** V. J. Tennery, T. N. Washburn, and J. L. Scott (Oak Ridge National Laboratory, Oak Ridge, Tenn.). In: Ceramics in severe environments; Proceedings of the Sixth University Conference on Ceramic Science, North Carolina State University, Raleigh, N.C., December 7-9, 1970. New York, Plenum Press, 1971, p. 587-599; Discussion, p. 599, 600. 9 refs. AEC-sponsored research.

Uranium mononitride is a candidate fuel for nuclear reactors for applications in space because of its high thermal conductivity, high fissile atom density, and dimensional stability at high temperature. High purity UN ceramics fabricated from nitride powders by uniaxial

or isostatic pressing and sintered in nitrogen at temperatures exceeding 2000 C, were irradiated at fuel temperatures to 1500 C and 2 wt % burnup. Results indicate no chemical reaction zone between fuel and metallic cladding, fuel swelling less than 2.8% per atomic per cent burnup, and maximum fission gas release of 7% of that generated. (Author)

A72-28879 # **Future patterns of aircraft operations and fuel burnouts with remarks on contrail formation over the United States.** W. B. Beckwith (United Air Lines, Inc., Chicago, Ill.). In: International Conference on Aerospace and Aeronautical Meteorology, 1st, Washington, D.C., May 22-26, 1972, Preprints.
Boston, American Meteorological Society, 1972, p. 422-426. 12 refs.

An attempt is made to forecast turbine aircraft fuel burnouts to obtain data necessary for estimating the total effects of exhaust products on air quality. Altitude, seasonal, and latitudinal variations in fuel burnout are examined. The problem of contrail formation is discussed, and preliminary contrail observational findings are presented. O.H.

A72-29451 # **Theoretical investigation of combustion-product parameters for a natural gas burning in oxygen (Teoreticheskie issledovaniia parametrov produktov sgoraniia pri szhiganii prirodnogo gaza v kislorode).** N. N. Popov and L. F. Ial'nitskii. *Samoletostroenie i Tekhnika Vozdushnogo Flota,* no. 26, 1971, p. 3-8. In Russian.

The principal thermodynamic parameters of the gas resulting from the combustion of natural gas in an oxygen atmosphere are calculated. The gas temperatures in the combustion chamber and at the nozzle exit section and the gas flow rates are plotted against the pressure (1.72 to 25 atm abs) and the excess oxidant ratio (0.5 to 3). It is shown that for each pressure there is an optimal excess oxidant ratio for which the combustion temperature is maximal. The thermodynamic parameters are compared with those obtained for a hydrocarbon fuel burning in oxygen. V.P.

A72-36162 # **Simulations of the radioactive decay of Th/228/ used in the form of ThO2 as a heat source for thermionic energy conversion.** R. J. E. De Bruyne (Bekaert, S.A., Zwevegem, Belgium), M. J. Brabers (Leuven, Katholieke Universiteit, Louvain, Belgium), and F. Casteels (Studiecentrum voor Kernenergie, Mol, Belgium). *International Atomic Energy Agency and European Nuclear Energy Agency, International Conference on Thermionic Electrical Power Generation, 3rd, Jülich, West Germany, June 5-9, 1972, Paper.* 11 p.

It is shown that ThO2, W and Pb are compatible for times in excess of 14 days at 1700 and 2000 C as materials for thermionic energy conversion. W can be effectively used as an oxygen getter in a ThO2(228) heat source. A large amount of energy can be obtained in a relatively short time from a ThO2(228) fueled thermionic converter, with a close to negligible vaporization of ThO2 and Th(WO4)2. V.Z.

A72-36169 # **State of development of an actinium fueled thermionic generator.** H. Birnbreier, G. Gammel (Brown, Boveri et Cie. AG, Mannheim, West Germany), G. Dumont, M. Poskin (Union Minière, Brussels, Belgium), L. H. Baetsle, W. van Lierde (Centre d'Etude de l'Energie Nucléaire, Mol, Belgium). *International Atomic Energy Agency and European Nuclear Energy Agency, International Conference on Thermionic Electrical Power Generation, 3rd, Julich, West Germany, June 5-9, 1972, Paper.* 14 p. Research sponsored by the Bundesministerium für Bildung und Wissenschaft.

A73-12955 # **The investigation of the effect of acoustic oscillations on the combustion process of gaseous fuel (Zur Untersuchung der Einwirkung der akustischen Schwingungen auf den Verbrennungsvorgang des gasförmigen Brennstoffes).** Iu. Ia. Borissov, E. I. Rosenfeld, and V. G. Smolenskii (Akademiia Nauk SSSR, Akusticheskii Institut, Moscow, USSR). In: International Congress on Acoustics, 7th, Budapest, Hungary, August 18-26, 1971, Proceedings. Volume 1. Budapest, Akademiai Kiado, 1971, p. 249-252. 8 refs. In German.

Particular attention in the study was given to peculiarities regarding the propagation of the acoustic waves in the flame. In the investigations natural gas was burned in cylindrical chambers. The effect of the acoustic oscillations was determined on the basis of changes in carbon dioxide concentrations and temperature in the flame. It was found that the sound effects caused an enhancement of the turbulence in the combustion chamber. G.R.

A73-15867 # **Pollutants from methane fueled gas turbine combustion.** P. G. Parikh, R. F. Sawyer (California, University, Berkeley, Calif.), and A. L. London (Stanford University, Stanford, Calif.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Nov. 26-30, 1972, Paper 72-WA/GT-3.* 8 p. 14 refs. Members, $1.00; nonmembers, $3.00. U.S. Environmental Protection Agency Grant No. AP-385.

In view of the greater flexibility of a gas turbine combustion system design as compared to that for a piston engine, control of nitric oxide emissions even while keeping the CO and hydrocarbon emissions at very low levels appears feasible. Factors influencing the production of these pollutants in a methane fueled gas turbine type combustor are studied in this investigation by analyzing the gas samples taken at various locations within the combustor. Increasing the homogeneity of the primary zone gas composition by using gaseous or prevaporized liquid fuels is found to be an effective way to reduced nitric oxide emissions. (Author)

A73-16382 **A theoretical study of geothermal energy extraction.** F. H. Harlow and W. E. Pracht (California, University, Los Alamos, N. Mex.). *Journal of Geophysical Research,* vol. 77, Dec. 10, 1972, p. 7038-7048. 7 refs. AEC-sponsored research.

Efficient extraction of geothermal energy from a dry well depends on the ability to establish a closed pressurized circuit of water through a large zone fractured in hot impermeable rock. Long-term perpetuation of significant power extraction depends, in addition, on the ability to extend the initial fracture zone through the effects of thermal stress cracking of the adjacent hot rocks. In support of an experimental program to test the feasibility using this type of energy source, the combined equations describing the coupled processes of fluid flow, heat transport, and rock fracture were solved numerically. The results show a strong dependence on the extent to which underground pressure can be maintained and the fracture zone continuously extended. They indicate that under favorable, but perhaps not unreasonably exotic, circumstances the extraction of significant thermal power from each well can be expected to continue for many decades. (Author)

A73-16687 # **Suppression of evaporation of hydrocarbon liquids and fuels by aqueous films.** J. T. Leonard and J. C. Burnett (U.S. Navy, Naval Research Laboratory, Washington, D.C.). *Combustion Institute, Fall Meeting, U.S. Naval Postgraduate School, Monterey, Calif., Oct. 30, 31, 1972, WSCI Paper 72-27.* 33 p. 23 refs.

A73-17192 **Accurate localization by the Geole Project satellite (Localisation précise par satellite Projet Géole).** D. Thieriet (Centre National d'Etudes Spatiales, Brétigny-sur-Orge, Essonne, France). *L'Aéronautique et l'Astronautique,* no. 37, 1972, p. 43-53. In French.

Review of some of the problems raised by space activities devoted to earth surface observations for various specific purposes, and description of the main features of the French geodetic Geole-Project satellite. Following a definition of the localization accuracy and speed requirements of oil-prospecting, geodetic, cartographic, topographic, and glaciological tasks, as well as of their respective occurrence frequency, the desirable features of geostationary and nongeostationary satellite systems for the performance of such tasks are considered, and the system selected for the Geole Project is described in terms of its undelying principle, orbit, chosen frequency bands and signals, antennas, and performance capabilities. M.V.E.

A73-22819 **Thermionic fuel element development status summary.** J. W. Holland (Gulf General Atomic Co., San Diego, Calif.). In: Intersociety Energy Conversion Engineering Conference, 7th, San Diego, Calif., September 25-29, 1972, Proceedings. (A73-22751 09-03) Washington, D.C., American Chemical Society, 1972, p. 1060-1065. 8 refs.

Operating and environmental requirements of the thermionic fuel element (TFE) under development for the AEC is summarized in this paper for the various space applications of in-core thermionic reactor power plants. The approach and program milestones for TFE development are briefly reviewed followed by a description of the key technologies under study. Technology status is compared to the requirements of the various applications. (Author)

A73-23682 # **Aircraft of the future (Flugzeuge der Zukunft).** I. Tolztych. *(Grazhdanskaia Aviatsiia,* no. 6, 1972, p. 18, 19.) *Technisch-ökonomische Informationen der zivilen Luftfahrt,* vol. 8, no. 9, 1972, p. 419-424. In German. (Translation).

Evaluation of the technical and economic efficiency of types of aircraft likely to be developed in the coming decades. The problem of evaluating the degree of structural maturity and perfection of passenger aircraft and their economic efficiency is discussed. Problems connected with the development of increasingly high-speed subsonic aircraft, supersonic, and, ultimately, hypersonic aircraft are discussed, including engine designs, fuels, and noise reduction. In addition, the use of VSTOLs to provide more efficient transportation between airports and city centers is considered. A.B.K.

A73-25459 **Advances in organic geochemistry 1971; Proceedings of the Fifth International Meeting, Hanover, West Germany, September 7-10, 1971.** Meeting supported by the Bundesministerium für Bildung und Wissenschaft, Niedersächsische Landesregierung, et al. Edited by H. R. v. Gaertner and H. Wehner (Bundesanstalt für Bodenforschung, Hanover, West Germany). Oxford and New York, Pergamon Press (International Series of Monographs in Earth Sciences. Volume 33), 1972. 726 p. In English, French, and German. $45.

Results of field and laboratory experiments dealing with the geochemistry of rocks, soils, water, and isotopes are described along with research on the geology of coal and petroleum. Topics examined include the characterization and classification of fossil organic substances dispersed in sediments, laboratory simulation of organic geochemical processes, genetic criteria for defining oil types in sedimentary basins and for relating the oils to their source rocks, the origin and significance of organic matter in various environments, and features of coal and oil deposits in different localities. Techniques of analysis and the methodology of geochemical research are described extensively.

T.M.

A73-25465 * **The isolation of a series of acyclic isoprenoid alcohols from an ancient sediment - Approaches to a study of the diagenesis and maturation of phytol.** R. E. Cox, J. R. Maxwell (Bristol, University, Bristol, England), R. G. Ackman, and S. N. Hooper (Fisheries Research Board of Canada, Halifax, Nova Scotia, Canada). In: Advances in organic geochemistry 1971; Proceedings of the Fifth International Meeting, Hanover, West Germany, September 7-10, 1971. Oxford and New York, Pergamon Press, 1972, p. 263-276. 25 refs. Research supported by the Natural Environment Research Council; Grant No. NGL-05-003-003.

A73-25471 * **Proposed stratigraphic controls on the composition of crude oils reservoired in the Green River formation, Uinta Basin, Utah.** W. E. Reed and W. Henderson (California, University, Berkeley, Calif.). In: Advances in organic geochemistry 1971; Proceedings of the Fifth International Meeting, Hanover, West Germany, September 7-10, 1971. Oxford and New York, Pergamon Press, 1972, p. 499-514; Discussion, p. 514, 515. 26 refs. Grant No. NGL-05-003-003.

A73-29734 * **17alpha/H/ hopane identified in oil shale of the Green River formation /Eocene/ by carbon-13 NMR.** B. Balogh, D. M. Wilson, P. Christiansen, and A. L. Burlingame (California, University, Berkeley, Calif.). *Nature,* vol. 242, Apr. 27, 1973, p. 603-605. 14 refs. NASA-supported research.

During an investigation of C-13 NMR shifts and the structural correspondence of pentacyclic triterpenes a C-13 NMR study was conducted on one of the most abundant components of the hexane soluble fraction of oil shale bitumen of the Green River formation. A rigorous proof was derived exclusively from C-13 NMR data for the structure of the important triterpenoid fossil molecule. It was established that the structure of the isolated triterpane was 17alpha(H) hopane. G.R.

A73-33185 # **Rotary wing economics in a time of changing social values.** J. A. McKenna (United Aircraft Corp., Sikorsky Aircraft Div., Stratford, Conn.). In: Anglo-American Aeronautical Conference, 13th, London, England, June 4-8, 1973, Proceedings. London, Royal Aeronautical Society, 1973. 9 p.

Review of some of the ecological advantages of using helicopters for carrying out logging operations, passenger transport, and offshore oil exploration and production. It is shown that rotary-wing aircraft have provided access to critical lumber resources without causing a harmful environmental impact on the forests. Another advantage of the helicopter is that its use for short-haul air transportation will save land that would otherwise be wasted on large airports. Finally, the economic advantage of using helicopters for offshore oil production and transportation (particularly in the North Sea) to avoid undue dependence on Middle East sources is stressed. A.B.K.

A73-33360 **Quantitative thermal mapping problems.** C. O. Thomas and F. M. Shofner (Environmental Systems Corp., Knoxville, Tenn.). In: Operational remote sensing; Proceedings of the Seminar, Houston, Tex., February 1-4, 1972.
Falls Church, Va., American Society of Photogrammetry, 1972, p. 141-144; Discussion, p. 145.

Major attention is given toward thermal mapping applications at electrical power generating sites, i.e., the mapping of the thermal outfall from fossil or nuclear fuel plants. The material is stated from the viewpoint of the client, rather than the equipment manufacturer or survey firm. This is considered to be the application area with the greatest present need for quantitative thermal information, and the application with the greatest technical potential for airborne thermal mapping. Complete thermal analysis requires three-dimensional data. The data-tape route is believed to be superior to the direct record route for quantitative or even qualitative operations and, even with data tape methods, the eventual film imagery should not be viewed as the 'quantitative' record. F.R.L.

A73-36250 # **The spread of oil in the Arctic.** D. P. Hoult (MIT, Cambridge, Mass.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 6th, Palm Springs, Calif., July 16-18, 1973, Paper 73-701.* 9 p. 9 refs. Members, $1.50; nonmembers, $2.00.

The problem of oil spreading over Arctic ice is studied, the main topics considered being the rate of spread of oil released from a point on the surface, and the size attained by the area of the oil slick before it is caught in the pockets of the ice surface. The random character of the ice surface controls the final size of the oil slick and its rate of spread. It is found that, properly scaled, field data are in good agreement with both laboratory data and theory. These results serve to provide an understanding of the potential for oil pollution when oil is spilled in the high Arctic on either tundra or pack ice with no leads. F.R.L.

A73-38427 # **Compatibility of the MHW-RTG heat source materials.** D. Pavone (California, University, Los Alamos, N. Mex.), J. D. Watrous (Donald W. Douglas Laboratories, Richland, Wash.), and P. E. Brown (General Electric Co., Philadelphia, Pa.). In: Intersociety Energy Conversion Engineering Conference, 8th, Philadelphia, Pa.,

August 13-16, 1973, Proceedings. Addendum. New York, American Institute of Aeronautics and Astronautics, Inc., 1973, p. 89-112. 14 refs. Contracts No. AT(29-2)-2831; No. AT(45-1)-2138; No. W-7405-eng-36.

The maximum operational temperatures which the multi-hundred watt radioisotope thermoelectric generator heat source must maintain and the possible thermochemical environments to which it may be subjected by accident, impose special requirements for compatibility among the heat source materials. The radioisotope fuel, Pu-238 is used in the form of the dioxide; the primary containment material is a shell of elemental iridium. An impact shell of carbon in the form of graphitized, impregnated fibers protects the primary containment from rupture in the case of accidental impact. The compatibility of these materials among themselves has been demonstrated by a series of tests at both operational and reentry temperatures. The test conditions imposed and the test results observed are reported. The data supporting the selection of the PuO_2 + Ir + C materials system, in preference to other candidates are presented. (Author)

A73-38429 # **Design of a curium-244 heat source for the multi-hundred watt generator.** R. D. Casagrande and J. A. Garate (General Electric Co., Philadelphia, Pa.). In: Intersociety Energy Conversion Engineering Conference, 8th, Philadelphia, Pa., August 13-16, 1973, Proceedings. Addendum. New York, American Institute of Aeronautics and Astronautics, Inc., 1973, p. 117-128. 13 refs. Contract No. AT(29-2)-2831.

A preliminary design concept of a 3200-W curium-244 heat source sized for the multihundred watt radioisotope thermoelectric generator (MHW-RTG) is presented. The RTG utilizes 312 SiGe thermocouples, operates at a hot junction temperature of about 1000 C, and is designed to produce 193 W(e) at beginning of life and 125 W(e) after five years. The expected low cost and high power density of the curium-244 results in very desirable reductions in system cost and weight when compared to equivalent Pu-238 fueled systems. The curium RTG specific cost is estimated to be about $4900/watt and will deliver 2.9 watts/lb at beginning of life. This compares with a plutonium RTG specific cost of $16,000/watt and a specific weight of 1.8 watts/lb at beginning of life. (Author)

A73-38430 # **The availability and cost of curium-244 from power reactor fuel reprocessing wastes.** P. E. Brown (General Electric Co., Philadelphia, Pa.), E. Lamb (Oak Ridge National Laboratory, Oak Ridge, Tenn.), and D. G. Albertson (General Electric Co., Nuclear Energy Div., San Jose, Calif.). In: Intersociety Energy Conversion Engineering Conference, 8th, Philadelphia, Pa., August 13-16, 1973, Proceedings. Addendum. New York, American Institute of Aeronautics and Astronautics, Inc., 1973, p. 129-142. 43 refs. Contract No. AT(29-2)-2831.

The operation of a nuclear/electric power generating station will yield curium-244 as the product of six successive neutron captures in the uranium-238 which is the preponderant constituent of the nuclear reactor fuel. Projections of curium availability from the wastes generated in the reprocessing of typical light water reactor fuel cores are given. The sensitivity of curium production to the level of fuel burn-up and the effect on the quantity of curium produced, if plutonium-enriched uranium fuels are used, is discussed. Based on the projected availability and the possible chemical flow sheets, probable costs for the recovery of raw Cm-244 are developed. (Author)

A73-39895 # **Thermal activity of the Uson Caldera based on infrared and photographic aerial survey.** B. V. Shilin, N. A. Gusev, E. I. Vavilov, and E. Ia. Karizhenskii (Ministry of Geology, Laboratory for Aeromethods, Leningrad, USSR). In: International Symposium on Remote Sensing of Environment, 8th, Ann Arbor, Mich., October 2-6, 1972, Proceedings. Volume 2. Ann Arbor, Mich., Environmental Research Institute of Michigan, 1973, p. 1147-1157. 7 refs.

Currently, the study of thermally active geological regions has important significance not only from the aspect of studying the mechanisms of geothermal distribution processes, but also from the viewpoint of locating areas containing an important energy source - hot water. A method which enables one to quickly map large areas for the purpose of finding anomalous temperature regions is the recently developed infrared or thermal mapper. These mappers are sensitive to the thermal radiation emitted by the terrain in the 1.8 to 5.3 micron spectral intervals. Modern airborne IR equipment can detect temperature differences of the terrain with a high degree of sensitivity (tenths of a degree Celsius) which enables one to obtain an image of the terrain that approaches the quality obtainable by photographic means. The use of airborne IR mappers in surveying the thermally active volcanic regions of the Kamchatka penninsula is discussed and results of the survey are presented. (Author)

A73-39896 # **Geological analysis of aerial thermography of the Canary Islands, Spain.** R. S. Williams, Jr. (U.S. Geological Survey, Washington, D.C.) and D. Fernandopullé (UNESCO, Las Palmas, Canary Islands, Spain). In: International Symposium on Remote Sensing of Environment, 8th, Ann Arbor, Mich., October 2-6, 1972, Proceedings. Volume 2. Ann Arbor, Mich., Environmental Research Institute of Michigan, 1973, p. 1159-1194. 18 refs.

In May 1971, the seven main islands of the Canary Islands volcanic archipelago were surveyed with an airborne thermal infrared scanning radiometer. The survey objective was to locate, by thermal differences, any zones of ground water discharge (submarine springs) into the ocean. In addition, the geothermal area on Lanzarote, Montañas del Fuego de Timanfaya, and interior areas of other islands were surveyed. The seven principal islands and numerous islets of the Canary Islands group are volcanic in origin and trend in a northeast-southwest direction about 100 kilometers offshore from the Spanish Sahara. The islands are composed of several thick volcanic formations varying from basalts, trachytes, phonolites, ignimbrites to conglomeratic beds. (Author)

A73-40766 **Fuel capsule vent system development for the Viking radioisotope thermoelectric generator.** F. A. Schumann (Teledyne Co., Isotopes Energy Systems Div., Timonium, Md.). *Nuclear Technology*, vol. 19, Sept. 1973, p. 156-164. Contract No. AT(29-2)-2960.

A fuel capsule vent system was developed and designed for the radioisotope thermoelectric generator (RTG) in support of the upcoming Viking mission to Mars. Helium is continuously produced within the fuel capsule as a result of isotopic decay. By venting the helium external to the RTG, the initial RTG fill gas is maintained for maximum thermal efficiency. This reduces degradation of thermoelectric converter performance and provides the maximum electrical power for the mission. (Author)

A73-41172 # **Arctic resources airplane transportation system.** M. T. Friedl. *RAeS, AIAA, and CASI, Anglo-American Aeronautical Conference, 13th, London, England, June 4-8, 1973, Paper.* 25 p.

A transportation system specifically designed to move natural resources, primarily crude oil or liquid natural gas (LNG) out of the arctic by air is discussed. A typical gross weight for the aircraft is 3,500,000 lb, carrying a payload of over 2,000,000 lb at a relatively low Mach number at altitudes up to 40,000 ft. As a liquid natural gas transporter, 35 aircraft of this size in operation at 1800 n mi range are equivalent in capacity to a 48-in. gas pipeline. The importance of design for low cost is emphasized, and various configurations are evaluated. Attention is given to aspects of cargo handling and terminals. F.R.L.

N68-10240# Aeronautical Chart and Information Center, St. Louis, Mo. Linguistic Section.
DATA OF GRAVIMETRIC SURVEYS AND PROBLEMS OF DIRECT SEARCH FOR OIL AND GAS ON THE MONZHUKLY STRUCTURE [RESUL'TATY GRAVIMETRICHESKIKH ISSLEDOVANIY S ZADACHEY PRYAMYKH POISKOV NEFTI I GAZA NA STRUCTURE MONZHUKLY]
B. I. Kireyev Jul. 1967 6 p refs Transl. into ENGLISH from Razved. Geofys. (Moscow), no. 8, 1965 p 104–108
(ACIC-TC-1217; TT-67-62630; AD-656991)

Gravimetric measurements along three profiles were taken on the Monzhukly structure. A weak gravity minimum was noted in the crest part of the Monzhukly fold. I. G. Modoviskiy hypothetically explained its nature by the presence of screened gas and oil deposits in the northern part of the block of the fold. A detailed gravimetric survey was conducted for the determination of this minimum. This detailed survey made it possible to outline more precisely the general relative gravity maximum, corresponding to the structure, and to separate against its background a relative gravitational minimum. A comparison between the data of the gravimetric survey and the geological map distinctly shows the confinement of the minimum to the northern block of the fold. In the Monzhukly region, the given minimum could be caused by the influence of the terrain relief not being sufficiently taken into account, by errors in the determination of the Bouguer correction, by the presence of oil and gas deposits in the interior part of the fold, by the lithologic-structural characteristic of the fold. The paper discusses the above possibilities and explanations, with the conclusions drawn from the gravimetric and geologic studies.
Author (TAB)

N68-10414 Technische Hogeschool, Eindhoven (Netherlands).
ON THE MECHANISM OF THE GENERATION OF PETROLEUM
Jan Willem Jurg (Ph.D. Thesis) 26 Sep. 1967 56 p refs

Current thinking on the origin and generation of crude oil is reviewed, including the generation of hydrocarbons from a straight chain fatty acid. Experiments were conducted to determine if the water in sediments was a significant factor in petroleum generation, and behenic acid and clay were mixed with enough water to insure its presence as a liquid at the temperature of heating. At temperatures around 250°C, hydrocarbons and fatty acids were generated from the behenic acid–clay mixture, although less hydrocarbon resulted in experiments with water than without. It is concluded that because isomerization is strong in the experiments without water, carbonium ions act as intermediates in the generation of low molecular weight hydrocarbons; while the water experiments with less isomerization produce radicals as intermediates. In both the water and waterless experiments, radicals were the intermediates in the formation of long chain n-alkanes and fatty acids; and a mechanism is suggested for the generation of homologous series of these long chains from an even-numbered fatty acid.
M.W.R.

N68-10864 Commissariat a l'Energie Atomique, Saclay (France).
DESIGN OF A PILOT CELL FOR STRONTIUM-90 EXTRACTION BY SOLVENT [PROJET DE CELLULE PILOTE D'EXTRACTION PAR SOLVANT DU STRONTIUM 90]
J. Fradin Brussels EURATOM Sep. 1967 108 p In FRENCH; ENGLISH summary
(Contract EURATOM-025-62-10- RISF)
(EUR-3613.f)

The design of this plant was undertaken with the object of constructing a pilot apparatus for the study of the separation of the elements contained in fission products. The plant should yield technological information as well as data on the process (efficiency, Kd value, etc.). It is also felt that this plant might serve as a basis for the design of a unit for the production of strontium-90 and rare earths for treating effluent solutions from an irradiated fuel reprocessing plant. The report includes a description of the process and an examination of the safety precautions, the equipment, and the controls, measurements and monitoring and regulating devices.
Author

N68-11281# Atomics International, Canoga Park, Calif.
HEAVY WATER ORGANIC COOLED REACTOR. THE PREPARATION OF URANIUM CARBIDE FROM ECONOMICAL URANIUM COMPOUNDS
L. A. Hanson 15 Aug. 1967 34 p refs Prepared jointly with Combustion Engineering, Inc.
(Contract AT(38-1)-430)
(AI-CE-73) CFSTI: HC $3.00/MF $0.65

The preparation of uranium carbide (UC) from uranium tetrafluoride, ammonium diuranate (ADU), and uranium trioxide (UO_3) was studied on a gram scale to establish basic process parameters for economic comparison with the conventional UO_2 to UC fabrication method. The process developed in each case involved compacting blended powders (which were, respectively, UF_4–SiO_2–C, $(NH_4)_2U_2O_7$–SiO_2–C, and UO_3–C) and heating in vacuum in stages to convert the uranium compound to UO_2 at temperatures up to 850°C and carbothermically reduce the resulting UO_2 to UC at temperatures above 1300°C. The SiO_2 was used in the ADU conversion to remove a fluorine contaminant without uranium loss. Uranium carbide of controlled carbon content and low oxygen content was produced from each of these compounds. Uranium carbide was prepared from ADU in 20-kg quantities to demonstrate production scale-up of one of the processes studied. The UC produced was of equivalent or better quality than that produced from UO_2 under similar conditions. An economic comparison indicated that there are potential savings in using each of these materials, depending on the uranium source, instead of UO_2 for UC production. Quantitative evaluation of experimental results and overall economics indicates that only marginal savings may be gained by using ADU and UO_3; but a cost reduction is expected using UF_4.
Author (NSA)

N68-12420# Oak Ridge National Lab., Tenn.
A SURVEY OF EQUILIBRIUM FUEL-CYCLE COSTS FOR A LOW-ENRICHED, UNCLAD, HELIUM-COOLED UO_2 GRAPHITE REACTOR
C. M. Podeweltz Jun. 1967 55 p refs
(Contract W-7405-ENG-26)
(ORNL-TM-1789)

A survey of equilibrium, fuel-cycle costs associated with various combinations of lattice pitch, enrichment and fuel-hole size has been carried out for a gas-cooled, unclad, UO_2-graphite reactor. The UO_2 was assumed to be formed into pellets with no coating applied. Nineteen UO_2 holes intermingled with 42 coolant channels comprised a central cluster region in the graphite cell. Enrichment was varied in the range of natural to 5%; lattice pitch in the range of 10.8 to 14.8 in. Two fuel-hole dia, 0.375 and 0.576 in., were investigated. The reactor was assumed to deliver 1900 MW(t) and 760 MW(e). Multigroup, point-depletion calculations of the homogenized cell were performed utilizing GAM self-shielded, resonance cross sections and flux-weighted THERMOS cross sections. For the set of small fuel-hole reactors a minimum fuel-cycle cost of 1.314 mills/kWhr(e) was found. The reactor for which this cost obtained had a conversion ratio of 0.551, and a burnup of 41,083 MWd/t. For the large fuel-hole set the corresponding values were 1.160, 0.637, and 29,400
Author (NSA)

N68-12553# Oak Ridge National Lab., Tenn.
COMPARATIVE EVALUATION OF SOL-GEL FUEL FABRICATION COSTS
T. N. Washburn, A. L. Lotts, and F. E. Harrington Sep. 1967 55 p refs Presented at the CNEN Symp., Turin, 2–3 Oct. 1967
(Contract W-7405-ENG-26)
(ORNL-TM-1979; CONF-671008-2) CFSTI: HC $3.00/MF $0.65

Estimates were made of the costs of fuel preparation and fabrication of sol-gel metal-clad $(U,Pu)O_2$ fuel elements. Four processes were compared, and their costs, including hardware, were: low-energy packing of microspheres, $331/kg; vibratory compaction, $337/kg; pelletizing, $342/kg; and sol-gel extrusion, $331/kg for 0.220-in.-dia UO_2-18% PuO_2. These costs include only the plant operating expenses and capital charges at a fixed annual rate of 22%. The hypothetical plant produces 500 kg of core fuel per day to support a fast reactor industry of 15,000 MW(e). Costs of fuel material, fuel losses, inventory, and scrap recovery were not included, since they are the same for all the processes. Projected technology indicates little economic difference among the four processes, and each could be an excellent contender for production of fast reactor fuel. Continued development is needed to define more adequately the technical and economic capabilities and limitations of the four methods. Author (NSA)

N68-12884# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
CRITICAL EXPERIMENTS WITH ORGANIC MODERATORS—MONOISOPROPYL DIPHENYL AND GAS OIL [KRITICHESKIYE OPYTY S ORGANICHESKIMI YAMEDLITELYAMI-MONOIZOPROPILDIFENILOM I GAZOYLEM]
Yu. N. Aleksenko, V. I. Buynitskaya, V. V. Zaslavskiy, N. V. Zvonov, and V. N. Kozlov 3 May 1967 15 p Transl. into ENGLISH from Issled. po Primeneniyu Organ. Teplonositeley Zamedliteley v Energ. Reaktorakh (USSR), 1964 p 182–193
(Contract AF 33(657)-16410)
(FTD-HT-66-746; TT-67-63251; AD-660438)
The article presents the results of critical tests on the organic moderators isopropylbiphenyl and gas oil, a description of an experimental "organic reactor," and some results of measurements carried out on this reactor. Graphs are included showing the distribution of thermal neutrons for different values of lattice spacing, the calculated dependence of the effective addition for gas oil and monoisopropylbiphenyl, the dependence of the critical number of channels for monoisopropylbiphenyl on the lattice spacing and for gas oil on both the temperature and lattice spacing, as well as the calculated values of the square length of moderation for biphenyl, monoisopropylbiphenyl, and gas oil. It is concluded that the physical experiments with critical assemblies carried out on monoisopropylbiphenyl and gas oil have made it possible to verify the method and system of constants used for calculating the physical characteristics of reactors with organic heat-transfer agents. Author (TAB)

N68-15630# Naval Scientific Technical Information Center, London (England).
THE DETERMINATION OF SULPHUR IN PETROLEUM PRODUCTS
K. Krumbholz and G. Jaeckel Aug. 1967 9 p refs Transl. into ENGLISH from Chem. Tech. (Berlin), v. 17, no. 10, Oct. 1965 p 619–620
(NSTIC/13106/67; NSTIC-TRANS-1848; AD-662486)
In the fuel industry, the most usual method for the determination of total sulphur in petroleum is the oxidation principle by combustion of the sample in a stream of oxygen or air, followed by determination of the sulphur as sulphate. The extensive field of usefulness and the efficiency of the hydration method of sulphur determination are given. All industrial petroleum products, including low-temperature lignite tar, can be analysed by the hydration method. Besides these good results of sulphur determination by the hydration method, the consequent improvement in productivity compared with the method of oxyhydrogen gas deserves special mention, the improvement being as much as 500%. This is attained by working with minimal sample quantities and the elimination of the tedious preparation of the absorption solution for the analysis of the sulphate. Author (TAB)

N68-15844# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
INSTRUMENT FOR STUDYING THE OXIDIZABILITY OF PETROLEUM HYDROCARBONS AT HIGH TEMPERATURES
G. F. Bol'shakov 23 Oct. 1967 8 p refs Transl. into ENGLISH from Vyssh. Ucheb. Zaved., Izv., Neft' i Gaz, no. 9, 1964 p 61–63
(Contract NOw-62-0604-c)
(TG-230-T533; AD-663076)
A method for determining the oxidizability of fuels and lubricants by measuring the absorption of oxygen at high temperatures is described. The instrument used enables readings to be taken at constant pressure, thus avoiding errors due to fluctuations in atmospheric pressure. Author (TAB)

N68-17192# Comision Nacional de Energia Atomica, Buenos Aires (Argentina).
DETERMINATION OF URANIUM WITH A POTENTIAL-CONTROLLED COULOMETRIC TITRATOR [DETERMINACION DE URANIO CON UN TITULADOR CULOMBIMETRICO A POTENCIAL CONTROLADO]
Walter J. Krause and G. A. Dupetit 1967 25 p refs In SPANISH; ENGLISH summary
(CNEA-192)
The determination of uranium in the 2 to 20 mg per sample range with a potential-controlled coulometric titrator has been studied for the subsequent determination and control of the uranium concentration in solutions arising from the various phases in the irradiated fuel reprocessing plant. Therefore, the method is available in presence of aluminum and nitric in relatively large amounts and permits small quantities of Fe(III) and Hg(II). The determination is based on the U(VI)–U(IV) reduction in a potential-controlled mercury cathode cell, using 1M sulphuric acid as supporting electrolyte. The reduction mean time oscillates between 12 and 18 minutes and the obtained results agree within a standard deviation of 0,1 to 0,8%. A general outline about the electrical calibration of the titrator is given too, using furthermore an iron standard solution and a platinum electrode cell. Author

N68-17316*# California Univ., Berkeley. Lawrence Radiation Lab.
TREATISE IN ORGANIC GEOCHEMISTRY
Eugene Desmond McCarthy (Ph.D. Thesis) Aug. 1967 290 p refs
(Grant NsG-101-61; Contract W-7405-ENG-48)
(NASA-CR-93111; UCRL-17758) CFSTI: HC $3.00/MF $0.65 CSCL 08D
Major problems in organic geochemistry and their relation to the more fundamental scientific questions of chemical evolution and the origin of life were studied. In the experimental approach adopted in this treatise, almost all of the analytical techniques of modern organic chemistry have been utilised in the structural identification of the organic components isolated from a series of crude oils and sediments. Since the major part of the work has concentrated on the hydrocarbons, there has been a particular emphasis on capillary gas chromatography and mass spectrometry. The recent introduction of a combined gas chromatograph–mass spectrometer suggests that this instrument will be the most powerful analytical technique available to organic geochemists. Author

N68-17606 Joint Publications Research Service, Washington, D. C.
EXPLORATORY GEOPHYSICS IN THE USSR DURING THE YEARS OF SOVIET RULE (1917–1967)
V. V. Fedynskiy *In its* Soviet-Bloc Res. in Geophys., Astron., and Space, No. 174 19 Feb. 1968 p 140–172 Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Fiz. Zemli (Moscow), no. 11, Nov. 1967 p 90–112
The history of the development of exploratory geology is described, emphasizing applications to the national economy. Stress

is placed on the use of seismology in the petroleum industry, and prospecting for minerals is described. Improvements in making geophysical instruments are mentioned, and the most important tasks to be undertaken in the near future are identified. N.E.N.

N68-17607 Joint Publications Research Service, Washington, D. C.

DEVELOPMENT OF SEISMIC PROSPECTING METHODS IN THE USSR

N. N. Puzyrev *In its* Soviet-Bloc. Res. in Geophys., Astron., and Space, No 174 19 Feb. 1968 p 173-185 Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Fiz. Zemli (Moscow), no. 11, Nov. 1967 p 113-121

A brief history of the use of dynamic wave characteristics for prospecting purposes is presented. The refracted and reflected wave methods are identified as the most important, and development of increasingly sensitive intruments for signal measurement is mentioned. Locating petroleum fields is emphasized, and mineral prospecting is covered. The development of dynamic theories of wave propagation through different geological media is outlined, and the use of seismic waves in investigations of structural geology is described. N.E.N.

N68-19175# Shell Research, Ltd., Chester (England). Thornton Research Center.

INVESTIGATION OF THE PECULARITIES OF PRE-FLAME PROCESSES AND IGNITION OF HYDROCARBONS OF VARIOUS STRUCTURES. PART 1: VARIATION OF COOL FLAME DELAY AND IGNITION DELAY WITH COMPRESSION TEMPERATURE AND PRESSURE

A. N. Voinov and D. I. Skorodelov [1967] 17 p refs Transl. into ENGLISH from Kinetika i Kataliz (USSR), v. 8, no. 2, 1967 p 252-260 *Its* Transl. No. 1137

CFSTI: HC$3.00/MF$0.65

The effect of compression temperature and pressure on the ignition delay and cool flame delay of hydrocarbons of different structures (n-hexane, hexene-1, cyclohexane, cyclohexene, isooctane diisobutylene and a mixture of 60% isooctane with 40% n-neptane) in stoichiometric proportions with air, was investigated. Sharp differences in the nature of the preflame processes are demonstrated—as a function of the ignition delay—between saturated and unsaturated as well as between cyclic and acyclic hydrocarbons. Good agreement is shown between the variation of ignition delay with temperature for hydrocarbons of different structures and the peculiarities of their behaviour in engines, in particular the effect of temperature on the detonation tendency. Author

N68-19265# Rocket Flats Div., Dow Chemical Co., Golden, Colo.

STATIC BED REACTOR FOR STUDIES OF A PLUTONIUM HEXAFLUORIDE VOLATILITY PROCESS

Jerry D. Moseley and Herbert N. Robinson 5 Dec. 1967 19 p

(Contract AT(29-1)-1106)

(RFP-1048) CFSTI: HC$3.00/MF$0.65

Studies were begun to find if chemical separation and purification of plutonium from waste material could be achieved with fluoride volatility processes. Equipment designed for the project and for the procedures developed for use are described Author (NSA)

N68-19925*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

REACTIVITY EFFECTS CAUSED BY RADIAL POWER FLATTENING IN A SMALL, FAST-SPECTRUM REACTOR

C. L. Whitmarsh, Jr. Washington Apr. 1968 13 p refs

(NASA-TN-D-4459) CFSTI: HC$3.00/MF$0.65 CSCL 18I

The effect on criticality of flattening the radial power distribution in a small, reflector-controlled, fully enriched, fast-spectrum nuclear reactor was calculated. Compared to a uniformly fueled, fully enriched core, a decrease in reactivity occurred from reduced fuel inventory and an increase in reactivity occurred from enhanced reflector worth. Fuel distributions were also calculated to indicate the effects of (1) changing the power ratio of 1.1, and (2) changing the reflector thickness to 7.62 cm. Change (1) resulted in a zoned core with an enrichment variation from 71.3 percent in the central zone to 93.2 percent in the peripheral zone; whereas, for change (2) these values were 67 and 93.2 percent, respectively. The net reactivity loss (fuel loss–reflector worth increase) based on a 93.2 percent enriched uniformly-fueled core was 3 percent for either of these zoned cores. Power distortion in a reactor core is caused by reflector movement required to compensate for reactivity changes over the core lifetime. This effect in zoned cores was observed by calculating power shapes for the initial and the end-of-life reflector configurations for two zoned cores. Author

N68-21041# General Electric Co., Philadelphia, Pa.

APPLICATION OF RADIOISOTOPES FOR AEROSPACE WASTE RECLAMATION AND WATER SYSTEMS

Courtney A. Metzger (AMRL), Albert B. Hearld (AMRL), Bobby J. Reynolds (AMRL), Rufus Shivers (AEC), and Robert W. Murray Wright-Patterson AFB, Ohio AMRL Sep. 1967 17 p Proc. given at the 2d Intern. Symp. on Nucleonics, Columbus, Ohio, 12–14 Jul. 1967

(Contract AF 33(615)-3308)

(AMRL-TR-67-158; AD-665457)

A life support system designed for aerospace application was thermally powered by a radioisotope heat source at a significant saving in electrical energy. This report summarizes the research program and resulting design, development, and evaluation of a vacuum distillation-vapor pyrolysis water reclamation system that was subjected to a 30-day isotope powered unmanned test. In addition to the savings of electrical energy the application of a radioisotope heat source is expected to result in a simple and more reliable water recovery system producing an excellent quality water without the use of pre- or post treatment for extended periods of operation. Discussed are other water recovery processes that show good promise for the utilization of isotopes for the thermal energy that have been subjected to comparison evaluation using electrical energy. The use of several waste management techniques to obtain a complex integrated system are discussed including urine and fecal collection, fecal storage, potable hot and cold water storage and dispensing, and potability measurements that show promise for the use of the waste heat from the isotopes. TAB

N68-21048# Stanford Univ., Calif.

DISTRIBUTION OF HYDROCARBON FLUIDS AND THEIR COMPOSITIONS IN VOLATILE OIL RESERVOIRS DURING DEPLETION

James Grover Taylor, (Ph.D. Thesis) 1966 117 p

Available from Univ. Microfilms: HC $5.80/MF $3.00 Order No. 67-4439

Described is a technique for mathematically simulating the solution-gas drive performance of a volatile oil reservoir on a digital computer. In the mathematical model, it is assumed that the phase behavior of the reservoir fluids may be approximated by a ternary hydrocarbon system and that the reservoir fluids are always in a state of thermodynamic equilibrium. The relationships between the overall concentration of the individual hydrocarbon components and the characteristics of the gas-oil relative permeability curves are shown quantitatively. Approximately ten minutes of computer time (Burroughs 5500) per run are required for the constant production-rate calculations reported. The reservoir studied was a linear system but extension to a radial system is outlined. The analysis developed may also be extended to hydrocarbon systems with more than three components. Dissert. Abstr.

N68-22608# Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik.
SUPPLEMENTARY MATERIAL TO THE REPORT NUCLEAR FUEL REQUIREMENTS AND COSTS OF VARIOUS REACTOR TYPES IN GERMANY, KFK 366 [ERGAENZENDES MATERIAL ZUM BERICHT KERNBRENNSTOFFBEDARF UND KOSTEN VERSCHIEDENER REAKTORTYPEN IN DEUTSCHLAND, KFK 366]
H. Gruemm, D. Gupta, W. Haefele, P. Jansen, M. Recker et al Sep. 1966 246 p refs Transl. into ENGLISH from Rept. KFK-466
(KFK-466; AEC-TR-6859) CFSTI: HC$3.00/MF$0.65

The background material used in the preparation of the report KFK-366 is presented. A detailed representation is given of the analytical and numerical calculation methods. The projects discussed are nuclear fuel reserves and price development, nuclear energy reserves and the economy of nuclear power plants, mathematical model transformation of nuclear fuel elements in combined reactor systems, cost calculation, fuel cycle for reactors, estimation of future energy needs, and characteristic reactor data.
NSA

N68-23663# Ente Nazionale per l'Energia Elettrica (ENEL), Rome (Italy).
PROGRAM FOR USE OF PLUTONIUM IN THERMAL REACTORS [PROGRAMMA PER L'UTILIZZAZIONE DEL PLUTONIO NEI REATTORI TERMICI]
Brussels EURATOM Mar. 1968 52 p In ITALIAN; ENGLISH summary
(Contract EURATOM-092-66-6 TEEI)
(EUR-3890.I) CFSTI: HC$3.00/MF$0.65

The uranium fuel cycles for the two power plants were calculated, establishing the frequency and magnitude of reloads and the movements of fuel, and then the equivalent plutonium cycles were calculated. Taking the reference case for both plants to be the fuel cost calculated with an annual interest rate of 7.5% and a manufacturing price supplement of $20/kg, the industrial value of the fissionable plutonium was worked out. The preliminary calculations to evaluate the number of prototype plutonium elements needed to reach a critical minimum showed that the eight elements now being fabricated are amply sufficient for these experiments. The nuclear characteristics of these elements were studied. The elements will have three different fissionable Pu enrichments: 2.85%, 1.40% and 0.74%. A study was conducted to compare the dynamic behavior of the plants with cores loaded with uranium and plutonium respectively.
Author

N68-23895*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
TANKAGE SYSTEMS FOR A METHANE-FUELED SUPERSONIC TRANSPORT
Joseph D. Eisenberg and Rene E. Chambellan Washington May 1968 21 p refs
(NASA-TM-X-1591) CFSTI: HC$3.00/MF$0.65 CSCL 01C

The use of liquid-methane fuel promises economic improvement, but its cryogenic nature causes on-board storage problems. Should the fuel be loaded in a saturated condition, much fuel will flash off due to pressure reductions during climb. Pressurized tanks or subcooled fuel will solve this problem. Subcooled fuels require a pressurizing gas. Low solubility gases have low availability and must be salvaged. Bladders or stand-pipes to reduce the contact area may be used with soluble or condensible pressurizers. Analytical studies indicate that these methods, when used separately or in combination, offer potential solutions to the tankage problem.
Author

N68-24990# Rugby Coll. of Engineering Tech. (England).
A COLLECTION OF NOTES ON DIESEL ENGINE ECONOMICS
P. J. Lawrence 1967 105 p refs
(Rept.-1) CFSTI: HC$3.00/MF$0.65

Design and developments of 4 stroke Diesel engines over the past fifteen years are surveyed for some twenty engines in the speed range 800 to 1800 rev. per minute with emphasis on engine size. Graphs depict the trend in piston speed and engine outputs in terms of H.P./in.^{2} of piston area as a function of mean effective pressure. An effort is made to predict possible effects of thermal ratings on engine costs and weight. Also covered is residual fuel burning in its context of economic importance for electricity generation and marine propulsion.
G.G.

N68-25283*# Avco Corp., Lowell, Mass. Space Systems Div.
ISOTOPE REENTRY VEHICLE DESIGN STUDY: CONCEPTUAL DESIGN, PHASE 1A TOPICAL REPORT
May 1968 528 p refs
(Contract NAS3-10938)
(NASA-CR-72366; AVSSD-0071-68-CR) CFSTI: HC $3.00/MF $0.65 CSCL 18N

Document summarizes the Phase IA conceptual design effort on the Isotope Reentry Vehicle (IRV) study. The major objective of the study is to develop a preliminary design of a 25 KW_t Pu 238 IRV. Major design emphasis is on system safety and developability. The IRV is configured to meet minimum practical diameter and weight limits. During Phase IA various IRV, heat source, and heat-source heat exchanger concept combinations have been developed and evaluated. Three IRV systems have been recommended for detailed conceptual design evaluation in Phase IB.
Author

N68-25716*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
PROBLEMS OF INCREASING THE RELIABILITY OF AUTOMATIC MINING EQUIPMENT
L. G. Mel'kumov and V. B. Ginzburg Redstone Arsenal, Ala. Redstone Sci. Inform. Center 19 Apr. 1968 17 p Transl. into ENGLISH from Mekhaniz. i Avtomatiz. Proizv. (Moscow), no. 7, 1966 p 50–52 Prepared by Army Missile Command
(NASA-TM-X-61123; RSIC-786) CFSTI: HC $3.00/MF $0.65 CSCL 13I

Discussed are problems of reliability of automation equipment in coal mines. Special emphasis is placed on the actual operating reliability of the equipment, the nature of possible breakdown, and recommendations for improving reliability.
Author

N68-28954# Oak Ridge National Lab., Tenn.
TREND IN ATOMIC POWER GENERATION AND URANIUM RESOURCES
Teiji Kamiyama [1967] 14 p Transl. into ENGLISH from Genshiryoku Kogyo (Tokyo), v. 13, no. 2, 1967 p 5–8
(ORNL-TR-1825) CFSTI: HC$3.00/MF$0.65

Evaluation of the present trend in atomic power development and uranium supply is presented. Analysis of natural uranium resources in the free world is presented and requirements to 1985 are listed. Economics of ore processing and recovery for predicted requirements and uranium supply are described.
Author (NSA)

N68-29161# General Dynamics Corp., San Diego, Calif. General Atomic Div.
PROGRESS IN OPTIMIZING THE GAS-COOLED FAST BREEDER REACTOR
Raymond T. Shanstrom 29 Jun. 1967 19 p Presented at the Ann. Meeting of the Am. Soc. of Mech. Engr., Pittsburgh, Nov. 1967
(Contract AT(04-3)-167)
(GA-8032; CONF-671101-5) CFSTI: HC $3.00/MF $0.65

Fuel-cycle cost results are presented for variations in the design of a 1000 MW(e) gas cooled fast breeder reactor. Principal performance characteristics of the reference design are compared with values for both gas cooled and water cooled thermal reactors. Fuel cycle cost sensitivity to variations in the gas cooled fast breeder

parameters is discussed, and indications for future improvement in the design are examined. NSA

N68-30262# Atomic Energy Commission, Washington, D. C.
RADIOISOTOPES: PRODUCTION AND DEVELOPMENT OF LARGE-SCALE USES
May 1968 45 p *Its* Wash No. 1095
CFSTI: HC $3.00/MF $0.65

Systems using radioactive isotopes as sources of heat and radiation are described. Its applications to spacecraft power and propulsion, terrestrial electric power generation, and chemical processing and production are reported. Special emphasis is placed on radioisotope batteries and other SNAP power generators. Author

N68-33991# Atomic Energy Commission Research Establishment, Risö (Denmark). Reactor Physics Dept.
DESCRIPTION OF THE URU-PROGRAMME
P. L. Olgaard Jan. 1968 49 p refs
(RISO-M-684) CFSTI: HC $3.00/MF $0.65

The URU-program (Utilization in Reactors of Uranium) was prepared to allow an assessment of the natural uranium consumption of different types of uranium fuelled thermal reactors, i.e. non-breeders. In the first part of the program the number of MW_ed, the Pu-production and the amount of remaining U, all per t nat. U, are calculated. In the second part the integrated uranium consumption and plutonium production are calculated as functions of time for a system of reactors of a given type and with specified total capacity and power production. The cases of no recycling, of uranium cycling only and of plutonium and uranium recycling are considered. The report contains a derivation of the formulas used, instructions for the use of the programme, a print-out of the program, and a test example. Author

N69-11048# Comitato Nazionale per l'Energia Nucleare, Rome (Italy).
SOL-GEL RESEARCH AND DEVELOPMENT IN ITALY
M. Ziffero 1968 25 p refs Presented at IAEA Panel on Sol-Gel Processes, Vienna, 6 10 May 1968
(RT/CHI(68)28) Avail: CFSTI

Cursory research on sol-gel started at CNEN early in 1963; the preliminary results obtained on thoria and the increasing interest in fast reactor fuels suggested a larger program. Today a group of approximately twenty is engaged in full time activity on sol-gel development involving an annual budget of approximately $350,000. This sum however does not include the construction of special facilities (such as alpha labs) and the cost of the irradiation programs. Research on sol-gel follows parallel lines which include: basic chemistry of actinides in colloidal solution, mechanism of gelification and sintering; process chemistry and establishment of flow sheets; process development and research on specific unit operations, product evaluation, irradiation testing, economics. A description given of the results achieved along the different lines. Author

N69-11230# Brookhaven National Lab., Upton, N. Y.
HYBRID FOSSIL-NUCLEAR FUELED MHD POWER CYCLES
M. Steinberg, J. Powell, M. Beller, and B. Manowitz Jun. 1968 15 p ref
(BNL-12569) Avail: CFSTI

A description is given of three alternate combination fossil nuclear fueled MHD power cycles (combination of a coal gasifier with a MHD generator): H_2-O_2, $CO-O_2$, and $CO + H_2$–air. The reforming and combustion reactions in each cycle are described, and their advantages and disadvantages are compared. Energy balances and efficiencies are given. The original conceptual cycle is described in BNL-12319-R. NSA

N69-13334# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
COMPOSITION AND THERMODYNAMIC PROPERTIES OF THE COMBUSTION PRODUCTS OF NATURAL FUELS WITH IONIZING ADDITIVES [SOSTAV I PERMODINAMICHESKIYE SVOISTVA PRODUKTOV SGORANIYA PRIRODNYKH TOPLIV S IONIZIRUYUSHCHIMI DOBAVKAMI]
V. C. Yungman et al *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 221–232 refs (See N69-13314 03-03)
(SM-74/217) Avail: CFSTI

For the construction and operation of magnetohydrodynamic converters of thermal energy into electrical energy, operating on natural fuel, it is necessary to have information about the equilibrium composition and the thermodynamic properties of the combustion products of natural fuels with ionizing additives. Pertinent computations were carried out for the combustion of methane in air and in air–oxygen mixture for a wide range of temperatures and pressures and for different proportions of the fuel and the oxidant, both with and without ionizing additive. The results of these computations, in the form of i–s diagrams and tables of the equilibrium composition, are mentioned. Author

N69-15081# Mound Lab., Miamisburg, Ohio.
CRITICALITY ANALYSIS OF THE LARGE HEAT SOURCE SYSTEM CONTAINING PLUTONIUM 238 DIOXIDE FUEL
R. A. Wolfe 1 Oct. 1968 9 p refs
(Contract AT(33-1)-GEN-53)
(MLM-1532) Avail: CFSTI

A criticality analysis was made of a $^{238}PuO_2$ radioisotope heat source system that will provide 25 kW of thermal power to a Brayton cycle power conversion system designed for space application. The calculations revealed a considerable degree of subcriticality for the Large Heat Source System. The only credible mechanism that could result in criticality of the ^{238}Pu-fueled Large Heat Source System would be a massive meltdown of the capsules and reassembly of approximately one-fourth of the fuel in some container such as a reentry body. The occurrence of criticality would not create significant additional radiological hazards beyond or different in magnitude than those posed by possible fuel dispersal. Author (NSA)

N69-15237# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
RESULTS FROM USAEC PLUTONIUM UTILIZATION PROGRAMS CONDUCTED BY BATTELLE-NORTHWEST
F. G. Dawson, comp. 28 Aug. 1968 101 p refs Presented at the Intern. Atomic Energy Agency Panel on Plutonium Util., Vienna, 2–6 Sep. 1968
(Contract AT(45-1)-1830)
(BNWL-SA-2065; CONF-680924-1) Avail: CFSTI

A status report on the present technology of Pu is presented. Topics discussed include: Pu utilization; fuel characteristics of Pu; fuel fabrication; physics behavior; and Pu fueling in water reactors. NSA

N69-15543# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
PHOENIX FUEL EVALUATION IN A MARITIME REACTOR DESIGN
K. R. Wise and U. P. Jenquin Oct. 1968 38 p refs
(Contract AT(45-1)-1830)
(BNWL-851) Avail: CFSTI

The Consolidated Nuclear Steam Generator-II reactor concept was used as a reference design to compare fuel cycle costs for Pu fueled cores with a high ^{240}Pu content (Phoenix fuel) to costs for an enriched U base case core. The Phoenix fuel was found to be competitive with the slightly enriched U reference fuel. Results

are presented in graphical and tabular form, and the results and calculational methods are discussed. NSA

N69-17117# Gulf General Atomic, San Diego, Calif.
HTGR FUEL REPROCESSING: EFFECTS OF INCLUDING A SILICON CARBIDE COATING ON FERTILE FUEL PARTICLES
J. J. Shefcik 10 May 1968 16 p refs
(Contract AT(04-3)-167)
(GAMD-8661) Avail: CFSTI

Conceptual flow sheets and reprocessing costs were developed for recovery of thorium and uranium from HTGR fuel elements containing silicon carbide-coated fissile and fertile particles. Two cases were considered. In Case IIIB the fertile particles were processed, and the fissile particles isolated, packaged and stored for eventual disposal or future processing. In Case IIIB1, both types of particles are processed to recover the contained uranium. Flow sheets and costs were derived from those contained in an earlier study where only the fissile particles had a silicon carbide coating. A modified burn-leach head-end process is used to prepare the fuel components for separation and decontamination by solvent extraction. The estimated costs associated with the two cases are listed. The reprocessing charges given assume plant operation at its design capacity. No credit is included for the recovered thorium or fissile particle uranium. The incremental cost of recovery of the fissile particle uranium is $0.45. Author (NSA)

N69-17558# Oak Ridge National Lab., Tenn.
FUEL-CYCLE COST COMPARISONS FOR LOW ENRICHED URANIUM HIGH TEMPERATURE GAS-COOLED REACTORS
Don Steiner 9 Sep. 1968 57 p refs
(Contract W-7405-ENG-26)
(ORNL-TM-2173) Avail: CFSTI

Multigroup point-depletion physics calculations are performed for equilibrium fuel cycles without recycle; thermal-hydraulic performance and fuel cycle costs are determined for three fuel element designs. Power densities and pressure drops are calculated. Reactor design and operations parameters are given. Economics are detailed; data for the three fuel element designs are tabulated. NSA

N69-19229# Oak Ridge National Lab., Tenn.
DIFFUSION PROCESS FOR REMOVING TRITIUM FROM THE BLANKET OF A THERMONUCLEAR REACTOR
A. P. Fraas Dec. 1968 24 p refs
(Contract W-7405-ENG-26)
(ORNL-TM-2358) Avail: CFSTI

The tritium concentration in the blanket of a thermonuclear reactor is important both from the standpoint of its effect on the capital investment required and from the standpoint of possible embrittlement of the structural material. The size and cost of the system required to keep the tritium concentration to an acceptable level are important from the feasibility standpoint. The high diffusion coefficient for H diffusing through Nb makes it possible to design a tritium removal system for thermonuclear reactors. The proposed system entails tritium diffusion from the Li of the blanket as it circulates through the main heat exchangers built of Nb. These would be operated at about 1800°F and be used to boil potassium for a potassium vapor topping cycle. A stainless steel potassium condenser operating at about 1100°F would serve not only as the boiler for a steam cycle but it would also be designed to concentrate the tritium which would be drawn off as a noncondensable. Author (NSA)

N69-19605# Oak Ridge National Lab., Tenn. Metals and Ceramics Div.
COATED-PARTICLE FUELS
T. G. Godfrey, R. L. Beatty, J. L. Scott, J. H. Coobs, J. W. Prados et al Nov. 1968 142 p refs
(Contract W-7405-ENG-26)
(ORNL-4324) Avail: CFSTI

Information was surveyed on fabrication, characterization performance, and reprocessing plutonium, thorium, or uranium coated-particle fuels with emphasis on pyrolytic carbon-coated oxides and carbides. Processes used in fabrication include powder rolling and sintering, particle melting and sol-gel. Properties of pyrolytic carbon coatings and their dependency on coating conditions are discussed. Radiation effects on mechanical properties and dimensional changes and fission product retention behavior are given. The burn-leach and grind-leach processed for fuel reprocessing are described. NSA

N69-20205# Army Foreign Science and Technology Center, Washington, D. C.
GROWTH OF MICROORGANISMS IN MEDIA WITH PETROLEUM FUELS
N. N. Grechushkina 1968 9 p refs Transl. into ENGLISH from Vestn. Mosk. Univ. Ser. VI: Biol. Pochvoved. (Moscow), v. 23, no. 2, 1968 p 122–124
(AD-680804; FSTC-HT-23-785-68) Avail: CFSTI CSCL 6/13

It was ascertained that representatives of both Mycobacteria and Pseudomonas can grow in kerosene TS-1 and T-1, diesel and hydrogenated fuels. Mycobacteria mucosum and M. lacticolum grow well in kerosene and hydrogenated fuels. Diesel fuel with a sulfur content of 1.6% was utilized slightly by them; gasoline was not used at all. Pseudomonas grow well in kerosene TS-1 and T-1 and diesel fuel, and hydrogenated fuel and gasoline B-70. Thus, of all tested microorganisms, only the strain Pseudomonas pyocyaneum can grow in aeronautical gasoline. The intensity of growth of various strains of the same bacteria in the same fuel is not uniform. Author (TAB)

N69-21442# Israel Program for Scientific Translations, Ltd., Jerusalem.
NEW METHOD OF INVESTIGATING THE STRENGTH PROPERTIES OF TYPICAL ROCKS IN SOME COAL AND SHALE DEPOSITS
M. I. Koifman et al *In its* Mech. Properties of Rocks 1968 p 87–96 refs
Copyright. Avail: CFSTI

An effective method was applied in testing the strength of coals, combustible shales, aleurolites, sandstones, and limestones of low or medium strength. The method is distinguished by its simplicity and by the fact that several tensile and compression tests can be performed on each specimen. The new method was the first to afford a means of testing the strength of weak and fissured rocks or coals from which test pieces for testing by previously known methods cannot be prepared in practice, and which, as a consequence, could not be tested. A ratio of compression strength to tensile strength was determined for the samples tested; this ratio is an indicator for plasticity or brittleness. Author

N69-25510# Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires.
TREATMENT OF FUEL BY THE DRY METHOD. STUDIES PERFORMED IN FRANCE [TRAITEMENT DES COMBUSTIBLES PAR VOIE SECHE. ETUDES REALISEES EN FRANCE]
M. Bourgeois and P. Faugeras 1968 7 p refs In FRENCH Presented at Symp. on Nonaqueous Reprocess., Mol, Belgium, 28 Oct. 1968
(CEA-CONF-1195; CONF-681040-9) Avail: AEC Depository Libraries

Methods for treatment of fuels of uranium-base alloys and PuO_2–UO_2, based on the selective volatilization of UF_6 and PuF_6, are described. Mechanical and chemical decladding procedures and economic aspects of the treatment are included. NSA

N69-25563# Argonne National Lab., Ill.
NONAQUEOUS FUEL PROCESSING: RESEARCH CONDUCTED IN FRANCE
M. Bourgeois and P. Faugeras 1968 5 p ref Transl. into ENGLISH from French Conf. Presented at Symp. on Nonaqueous Reprocess., Mol, Belgium, 28–29 Oct. 1968
(ANL-Trans-704; CONF-681040-1) Avail: CFSTI

A research program dealing with nonaqueous irradiated fuel reprocessing is described first for alloys based on enriched uranium and then for breeder reactor fuels. Finally, a technical and economic comparison between the aqueous and nonaqueous processes is made. Author (NSA)

N69-26099# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
SPECIALIZED COMPUTER FOR THE CALCULATION OF OPTIMUM PARAMETERS OF TECHNOLOGICAL PROCESSES
A. S. Ruppo 14 May 1968 14 p Transl. into ENGLISH from Mekhaniz i Avtomatiz. Proizv. (Moscow), v. 20, no. 9, 1966 p 41–44
(AD-682791; FTD-HT-23-27-68) Avail: CFSTI CSCL 09/2

An analysis is made of a specialized computer designed to solve the problem of increasing the output of a coal treatment plant. The computer consists of a section for input of initial data in the form of enrichment curves, sections for computing values of the coordinates of these curves, units for input of values of the coefficients qi and the assigned value of average ash content of the overall concentrate, the decision element, tthe null-balance device, and the output unit. The computer works as follows: the values of average ash content of the concentrate and coefficient qi are loaded into the computer to determine the fraction of each of the classes of coal in percent of the total. During the process of solution, the values of the coordinates of the enrichment curves are calculated at points of equal derivatives M1 = M2M3 and the differential equations are solved at these points. When equality is achieved between the two halves of the equation, the null-balance device operates and the computing process is halted. The output device can be used to develop all the data of interest to the operator, such as total concentrate yield, yield of concentrate by classes, etc. Author (TAB)

N69-28160*# National Academy of Sciences—National Research Council, Washington, D.C. Div. of Engineering.
USEFUL APPLICATIONS OF EARTH-ORIENTED SATELLITES: GEOLOGY
1969 73 p refs
(Contract NSR-09-012-909)
(NASA-CR-101384) Avail: CFSTI CSCL 08G

Two primary goals are defined for the application of earth-oriented satellites to geology. (1) Regional geologic photomaps of North and South America could be provided by color photography from spacecraft and radar imagery from aircraft. These maps would serve as an aid to the exploration geologist in the search for new deposits of minerals and petroleum. (2) Spectral properties of minerals and rocks at various wavelengths could be studied to determine rock identity and geologic structure and also to recognize lithogic and structural conditions favorable for the occurrence of economic deposits of minerals and petroleum. A two phase program is proposed. The initial system, to be put into operation in two to three years, would consist of combined satellite–aircraft approach designed to provide useful geologic maps of the Americas. Later, sensing techniques that are more sophisticated than photography and radar would be used to determine detailed geological structure and rock identity. J.A.M.

N69-29789# Joint Publications Research Service, Washington, D.C.
CHEMISM AND PHYSICOCHEMICAL PROPERTIES OF PROCESSES OF MICROBIOLOGICAL OXIDATION OF PETROLEUM HYDROCARBONS
V. I. Karban et al 3 Jun. 1969 44 p refs Transl. into ENGLISH from USP. Khim. (Moscow), v. 38, no. 3 1969 p 539 559
(JPRS-48150) Avail: CFSTI

The article presents a survey of literature on the microbiological synthesis of protein substances from petroleum hydrocarbons. A general description is given of the process and the conditions of its occurrence, as well as the chemical mechanism of the microbiological oxidation of aliphatic, aromatic, and heterocyclic hydrocarbons. Particular attention is given to physiocochemical and topochemical peculiarities of the process. It is shown that from the physiochemical viewpoint the process under consideration resembles emulsion oxidation of hydrocarbons. Author

N69-30776# International Atomic Energy Agency, Vienna (Austria).
NUCLEAR TECHNIQUES AND MINERAL RESOURCES
1969 518 p refs Proc. of the Symp. on the Use of Nucl. Tech. in the Prospecting and Develop. of Mineral Resources, Buenos Aires, 5–9 Nov. 1968
Avail: CFSTI

The conference proceedings focused on ore geophysics and processing, uranium exploration, radioisotope X-ray fluorescence, and activation analysis. For individual titles, see N69-30777 through N69-30806.

N69-30790# Gearhart-Owen Industries, Inc., Fort Worth, Tex.
GAMMA-RAY LOGGING IN URANIUM PROSPECTING
W. K. Hawkins and M. Gearhart *In* Intern. Atomic Energy Agency Nucl. Tech. and Mineral Resources 1969 p 213–222 refs

(SM-112/15) Avail: CFSTI

Gamma ray systems that have a wide range response are required for uranium exploration. Low grade ore bodies with marginal economic feasibility are particularly dependent on reliable, calibrated gamma ray logs. Wide range gamma ray counting systems for this purpose are described, with emphasis on the downhole wide range gamma-gross count probe. Gamma detector types, calibration of the system, and interpretation methods are reviewed. The hardware characteristics are detailed to provide an understanding of equipment capabilities and limitations. It is necessary to discriminate between the valuable uranium ore and other radioactive materials, at present of little value. Gamma spectral logs are of considerable interest but available equipment limits the use of such techniques. Equipment limitations and possible improvements are covered. Author

N69-30799# Ministerului Petrolului, Ploesti (Rumania).
NUCLEAR TECHNIQUES CURRENTLY USED IN OIL FIELD EXPLOITATION
G. Peteu *In* Intern. Atomic Energy Agency Nucl. Tech. and Mineral Resources 1969 p 383–396 refs
(SM-112/24) Avail: CFSTI

A general survey is given of the present status and prospects of the techniques of nuclear geophysics, which are classified as follows: methods concerned with the investigation of geological formations, from the point of view of lithologic nature, content of clay, dolomite, anhydrite, etc., and based on the study of natural and induced radioactivity (making use of gamma and neutron radiation); methods concerned with petrophysical parameters (density, porosity, etc.), by means of which the collecting capacity of prospected geological formations can be qualitatively and quantitatively determined; methods for determining the nature of fluids present in deposits; and radiotracer methods, which are used extensively in the drilling, construction and operation of oil wells,

and also in various techniques concerned with exploitation of deposits, and secondary recovery. Particular importance is given to the development of spectral analysis in the study of natural, scattered and induced gamma-radiation, and also to radioactive tracer techniques. Author

N69-30800# Mobil Research and Development Corp., Dallas, Tex. Field Research Lab.
ADVANCES IN NUCLEAR GEOPHYSICAL METHODS IN OIL GEOLOGY AND ROCK ANALYSIS
R. L. Caldwell, W. R. Mills, and W. W. Givens *In* Intern. Atomic Energy Agency Nucl. Tech. and Mineral Resources 1969 p 397–413 refs
(Contract NASw-1435)
(SM-112/25) Avail: CFSTI

A summary is presented of a two year extensive study of the combination neutron method for analyzing surface rocks of the moon and planets. The combination method uses a pulsed accelerator source of 14-MeV neutrons and measurement of prompt gamma rays, capture gamma rays, activation gamma rays, and thermal and epithermal neutron die-away. As a result the new technique of cyclic neutron activation was developed which is applicable to lunar surface analysis, borehole logging, and on-stream analysis of rocks and minerals. Rock analysis studies have been made with a high resolution lithium-drifted germanium detector and a pulsed accelerator source of neutrons. The detector resolution of 0.5% at 1.3 MeV is about an order of magnitude better than for a good sodium iodide detector. Gamma rays arising from inelastic scattering of fast neutrons, capture of fast and slow neutrons, and activation were studied. From the results with the high resolution detector some interesting conclusions and speculations are made concerning the future of nuclear elemental analysis in the field. A new small-diameter pulsed accelerator neutron tool for logging through 2 1/2-in. tubing is described, and a pulsed neutron source using a plurality of alpha sources and beryllium targets with a rotatable shutter between them. Author

N69-30801# Institut de Physique Atomique, Cluj (Rumania).
MEASUREMENT OF ISOTOPIC DISTRIBUTION IN THE EVALUATION OF OIL FIELDS [MESURE DE LA DISTRIBUTION ISOTOPIQUE DANS L'EVALUATION DES GISEMENTS PETROLIFERES]
L. Blaga *In* Intern. Atomic Energy Agency Nucl. Tech. and Mineral Resources 1969 p 415–432 refs In FRENCH; ENGLISH summary
(SM-112/27) Avail: CFSTI

A general discussion is presented on the isotopic concentrations in newly opened hydrocarbon deposits which show certain regularities of distribution. The isotopic distribution existing between the different components of the fluids in oil-bearing deposits are the result of isotopic equilibrium or of a process tending towards such equilibrium. Agreement was obtained between the calculated values and those obtained, for example, in the methane-deposit water system. The isotopic concentration gradients, recorded over considerable distances within one phase, are primarily the result of a geothermal gradient. Two characteristic phases are noteworthy from the point of view of the distribution of isotopic concentration gradients in hydrocarbon deposits: (1) The starting phase of isotopic distribution, pre-existing in the deposit, is a result of the temperature gradients. This distribution can be incorporated in a system of isotopic isoconcentrates (lines of equal isotopic concentration), which can be correlated with the structure of the deposit and also with the various physical, chemical and mechanical factors characteristic of porous media. (2) The secondary phase of isotopic distribution corresponds to the period of operation. The exploitation process results in imbalances due to pressure and water flooding and in large-scale movements of oil from one zone to another. If the isotopic distribution of the starting phase is seen as an initial, natural isotopic labelling, it would appear possible to follow the changes in initial distribution as the exploration operations go on. Author

N69-31081# European Atomic Energy Community, Ispra (Italy). Reactor Physics Dept.
CAN THORIUM COMPETE WITH URANIUM? AN ASSESSMENT FOR HEAVY-WATER AND GRAPHITE MODERATED REACTORS
G. Graziani, C. Rinaldini, C. Zanantoni, J. J. Devos, and M. Paruccini May 1969 70 p refs
(EUR-4264.e) Avail: CFSTI

The cost of thorium fuel cycles with fully enriched uranium make-up and of natural and enriched uranium fuel cycles was investigated for D_2O moderated pressure tube and pressure vessel reactors and high-temperature gas-cooled reactors. The fuel cycle cost was optimized by a parametric investigation of burn-up, specific power and moderation ratio. A continuous charge–discharge fueling was assumed, with full recycle, partial and segregation schemes. The comparison between the fuel cycle costs of the uranium and thorium cycle shows a slight advantage for thorium under present economic conditions. The economic conditions which should be realized in order to make thorium more competitive are investigated by means of a parametric survey of the cost of fabrication, reprocessing, ore and separative work. Author

N69-31119# European Atomic Energy Community, Ispra (Italy).
PYROMETALLURGICAL CONCENTRATION OF ENRICHED URANIUM IN IRRADIATED MTR FUEL ELEMENTS [CONCENTRATION PYYROMETALLURGIQUE DE L'URANIUM ENRICHI DANS LES ELEMENTS COMBUSTIBLES MTR IRRADIES]
C. David, J. M. Junger, R. Lorenz, P. Montellanico, and J. G. Wurm Brussels May 1969 20 p In FRENCH; ENGLISH summary Presented at Symp. on Dry Reprocessing, Mol, Belgium, 28–29 Oct. 1968
(EUR-4243.f) Avail: CFSTI

The purpose of this process to be performed on the MTR reactor site, is to reduce: (1) the transportation costs of the uranium to the aqueous plant; and (2) the processing costs (reduced handling, smaller liquid waste volume). This method consists in melting down the fuel element (aluminum type) and concentrating the fissile material by precipitation through the addition of magnesium in which uranium is insoluble. The enriched uranium, concentrated at the bottom of the ingot as an intermetallic compound is cut off and shipped away. The laboratory experiments indicated that an uranium volume concentration of 20:1 is possible. A furnace was installed in the hot cell of the Ispra I reactor to melt spent MTR fuel elements. The first experiments performed on MTR dummy elements have demonstrated that the same results as for the laboratory experiments can be obtained. Author

N69-31161# Kernforsuchungszentrum, Karlsruhe (West Germany).
PHYSICS INVESTIGATIONS OF URANIUM-FUELED FAST STEAM-COOLED REACTORS IN SNEAK, ASSEMBLIES 3A-0, 3A-2, 3A-3
R. Schroeder, comp. Oct. 1968 87 p refs Sponsored by US-EURATOM
(EUFNR-608; KFK-847; EUR-3721.e) Avail: AEC Depository Libraries

Experiments on the SNEAK-3A series of assemblies are described for the physics characteristics of fast steam-cooled uranium reactors of about 500 l core volume at operating steam density. The steam was simulated by polyethylene foils. Two of the assemblies, corresponding to 40% (3A-1) and to 100% (3A-2) of the normal coolant density, have been investigated in considerable detail. Two more assemblies, investigated in less detail, have been obtained by voiding part of the core of assembly 3A-1 (viz. 3A-0) and by doubling the thickness of the polyethylene foils in part of

the core of assembly 3A-2 (viz. 3A-3). The experiments done at assembly 3A-0 and those done at assemblies 3A-2 and 3A-3 are discussed. Many of the experimental data are of direct interest to the designer of a steam-cooled fast breeder reactor, e.g., the critical mass, the reactivity coefficient of the coolant density and the ratio of the capture rate of ^{238}U to the fission rate of ^{235}U as a function of position, that is closely related to the breeding ratio. Author (NSA)

N69-31272# Atomic Energy Commission, Washington, D.C.
SELECTED BACKGROUND INFORMATION ON URANIUM ENRICHING
Mar. 1969 56 p refs
(ORO-668) Avail: US AEC Div. of Tech. Inform. Extension, P.O. Box 62, Oak Ridge, Tenn. 37830 at no cost

The seven separate steps of the nuclear fuel cycle (mining and milling, UF_6 conversion, enrichment, fabrication, irradiation, shipping, and reprocessing) are discussed. Typical cost experience for each step is included, with special emphasis placed on the enrichment step and its relation to the over-all fuel cycle. A description of gaseous diffusion plants is presented, including options and costs for increasing uranium enrichment capabilities. Current and long-term operational planning for optimization of power procurement, plant improvements, new plant additions, and level of preproduction are presented. Estimates are given of costs for operation of existing gaseous diffusion plants and capital investments for process improvements to the plants and construction of new plants. NSA

N69-31541# Du Pont de Nemours (E. I.) and Co., Aiken, S.C. Savannah River Lab.
SAVANNAH RIVER LABORATORY ISOTOPIC POWER AND HEAT SOURCES. PART 1: Co-60 Quarterly Progress Report, Oct.–Dec. 1968
H. S. Hilborn comp. Feb. 1969 19 p refs
(Contract AT(07-2)-1)
(DP-1192-1) Avail: CFSTI

Preliminary (theoretical) analyses indicated that CoO and CoO–MgO solid solutions are promising high temperature fuel forms of ^{60}Co. Extrapolation of stress-rupture data from the literature indicated that superalloy capsules will perform satisfactorily for 5 years at 1000°C or higher. Haynes 25 had the highest long-term strength of the materials tested. Satisfactory performance of an inactive Inconel 600 capsule at 1000°C for 10,000 hr (1.14 yr) was confirmed by destructive examination. More internal reaction than expected was revealed by destructive examination of two active capsules after 10,000 hr at 900°C. Author (NSA)

N69-31655# Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung.
FAST REACTOR CORE HEAT REMOVAL
D. Smidt Nov. 1968 38 p refs
(EURFNR-615; KFK-883; EUR-4162) Avail: AEC Depository Libraries

The problem of optimizing fast reactor design parameters while maintaining sufficient core cooling potentials is analyzed. The reactor model discussed has a core of multiple parallel metal clad rods filled with PuO_2–UO_2. Coolant possibilities which are analyzed include: gas, steam; and liquid Na. NSA

N69-31987 Purdue Univ., Lafayette, Ind.
FAST REACTOR BLANKET MANAGEMENT
James Madison Tilford (Ph.D. Thesis) 1968 289 p
Avail: Univ. Microfilms: HC $13.05/Microfilm $3.75 Order No. 69-2986

Present-day concepts of fast breeder reactor design call for fixed breeder blankets of natural or depleted uranium. This investigation was undertaken in order to determine an optimum blanket management scheme. Three types of radial blankets were considered: a one-batch stationary blanket, an in-out cycle, and an out-in cycle. The 1000-MWe Karlsruhe Na-1 Fast Breeder Reactor was chosen as the reference reactor for this study beacuse it is typical of present-day fast breeder concepts. This system is fueled with uranium-plutonium oxide, sodium cooled, and contains a natural UO_2 radial blanket. The results of the physical analyses indicate that the out-in and in-out blanket cycles have more favorable Pu^{239} distributions than the stationary blanket. This advantage results in lower heat generation and burnup rates, less neutron leakage, and larger breeding ratios than for the stationary case. Dissert. Abstr.

N69-33683# HRB-Singer, Inc., State College, Pa.
DETECTION, DELINEATION, AND MONITORING OF SUBSURFACE COAL FIRES BY AERIAL INFRARED SCANNING
W. M. Knuth, W. Fisher, Jr., and R. W. Stingelin *In* Mich. Univ. Proc. of the 5th Symp. on Remote Sensing of Environment Sep. 1968 p 877–881 ref
Avail: CFSTI

Coal mining regions have been plagued for many years by the nocuous effects of subsurface coal fires which begin beneath the culm, or coal refuse piles, and often burn into abandoned underground mines. The effectiveness with which these fires can be extinguished or controlled is largely dependent upon their early detection and accurate location. Drilling techniques are currently the most widely used means of delineating subsurface fires. Aerial infrared scanning, however, has the advantages of being more economical and faster and can provide a visual synoptic record. Modification of the scanning system permits electronic differentiation of the signal and provides for manual control of the level and gain settings of the amplifier. Improved detection of thermal detail in the fire areas resulted from such modification. The images reveal significant surface radiation variations from which inferences can be drawn regarding the extent and intensity of the fires. Author

N69-34967# Nuklear-Chemie Und -Metallurgie, G.m.b.H., Wolfgang Bei Hanau (West Germany).
TECHNOLOGICAL IMPROVEMENT IN THE FABRICATION OF CAST URANIUM CARBIDE RODS Final Report [VERBESSERUNG DER TECHNOLOGIE BEI DER FABRIKATION GEGOSSENER URANKARBID-STABE]
P. Himmelstein, H. Kuhn, O. Pfahls, and R. Lucas (EURATOM) Jun. 1969 40 p refs in GERMAN; ENGLISH summary
(Contract EURATOM-246-66-1 ORGD)
(EUR-4273.D) Avail: CFSTI

The aim was to develop a process for the economic fabrication of the nuclear fuel uranium monocarbide for the type of reactor developed in the Orgel Project. Work began with studies on the fabrication of uranium carbide from uranium dioxide and graphite powder. At the same time preliminary smelting tests were performed with small arc furnaces. The most favorable powders for the solid-state reaction together with the optimum conditions for the reaction were determined. Comprehensive studies were initiated on the influence of smelting conditions on the quality of uranium carbide rods. In arc smelting it was found that despite certain technical difficulties vacuum smelting was more suitable than shielding-gas smelting for the preparation of uranium carbide on a relatively large scale with a very low impurity fraction. Since the Orgel design requires uranium carbide rods to be fabricated with a well-defined surface area, all-round grinding of the rods is necessary. An account is given of the techniques used in cylindrical, cut-off, face and dishing grinding. The factors influencing the profitability of the process are discussed. Author

N69-35240# Combustion Engineering, Windsor, Conn.
REVIEW OF FBR CORE DESIGN PROBLEM AREAS
R. C. Noyes *In* Am. Nucl. Soc. Fast Reactor Systems, Mater. and Components [1969] p 437 – 444 refs
Avail: CFSTI

The FBR core design procedures are described. Topics discussed include: fuel cycle costs; flow characteristics in core; and heat transfer. NSA

N69-35243# Commonwealth Edison Co., Chicago, Ill.
UTILITY REQUIREMENTS IN FAST BREEDERS
C. B. Zitek *In* Am. Nucl. Soc. Fast Reactor Systems Mater. and Components [1969] p 454 – 458
Avail: CFSTI

The economic requirements for the development of fast breeder power reactors are analyzed as seen by the utility company. NSA

N69-37365# Dow Chemical Co., Golden, Colo. Rocky Flats Div.
FLUORIDE VOLATILITY Conference Proceedings
J. M. Cleveland, ed. and M. A. Thompson, ed. Oak Ridge, Tenn. AEC 1968 209 p refs Conf. Held at Rocky Flats, Colo., 24 – 25 Jun. 1968
(Conf-680610) Avail: CFSTI

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9. FLUORINATION OF ALL ENRICHMENTS OF URANIUM OXIDES J. G. Crawford (Goodyear Atomic Corp., Portsmouth, Ohio) p 130 - 139

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12. CONTAINMENT OF PuF_6 R. W. Kessie (Argonne Natl. Lab., Ill.) p 166 - 184 refs

13. ENGINEERING OF A PRODUCTION PROTOTYPE FLUORIDE VOLATILITY SYSTEM O. E. Heady p 185 198

N69-37567# Oak Ridge National Lab., Tenn.
REACTOR EVALUATION STUDIES
In its Chem. Technol. Div. Sep. 1968 p 225 – 237 refs (See N69-37551 22-06)
Avail: CFSTI

Continuing studies of various advanced reactor and fuel-cycle systems to determine engineering and economic feasibility are reported. Included are cost studies of shipping fresh and spent nuclear fuel; reprocessing spent fuel; and preparing various virgin and recycle fuel materials (oxides, metals, fluorides, etc.), primarily in support of the evaluation of civilian nuclear power for the period 1970-2020. Computer codes were developed to calculate rational growth patterns for the fuel cycle industry and to make projections of cost versus time for the various steps in the fuel cycle, based on both marketplace (nonoptimal) and optimal economic models. A computer code, was written to calculate individual fission product isotopes, fission product elements, groups of chemically similar elements, and their gross totals, as well as beta and gamma decay heat reslease rates. The program also calculates gamma photon release rates in terms of 16 energy groups for use in shielding calculations. Author

N69-38022# Commissariat à l'Energie Atomique, Marcoule (France). Centre de Production de Plutonium.
THE USEFULNESS OF THE DECAY RATE IN THE MANAGEMENT OF RADIOACTIVE WASTE STOCKS [DE L'INTERET DE LA DECROISSANCE POUR LA GESTION DES DECHETS RADIOACTIFS]
Jean Rodier and Gérard Cohendy May 1969 24 p refs In FRENCH; ENGLISH summary
(CEA-R-3731) Avail: CFSTI

It became apparent, during the first few years operation of the Marcoule Center, that it was very useful to exploit the natural decay rate of the radioactive element contaminating the

heat reslease rates. The program also calculates gamma photon release rates in terms of 16 energy groups for use in shieldinc calculations. Autho

N70-12102*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
COMPARISON OF ASTM-A1 AND NATURAL GAS FUELS IN AN ANNULAR TURBOJET COMBUSTOR
Donald F. Schultz, Porter J. Perkins, and Jerrold D. Wear 20 Oct. 1969 27 p refs
(NASA-TM-X-52700) Avail: CFSTI CSCL 21H

A preliminary study was made to determine possible problem areas in the use of natural gas fuel in aircraft turbojet combustors. A combustor designed for Mach 3.0 cruise operation with liquid ASTM-A1 fuel was operated with natural gas. The only change made to the combustor was in the fuel nozzle itself. Only one natural gas fuel nozzle design was used for these tests. Combustion efficiency, outlet temperature profiles, blowout and relight characteristics, flame radiation and smoke emission data were obtained. A comparison was made with data obtained from the same combustor using liquid ASTM-A1 fuel. The major problems encountered with natural gas were poor ignition and blowout characteristics. Author

N70-12263*# National Academy of Sciences-National Research Council, Washington, D.C. Div. of Earth Sciences.
SEISMOLOGY: RESPONSIBILITIES AND REQUIREMENTS OF A GROWING SCIENCE. PART 1: SUMMARY AND RECOMMENDATIONS
1969 45 p Sponsored in part by AROD, AEC, ARPA, ESSA, NSF, and US Geol. Survey
(Contract NSR-09-012-915)
(NASA-CR-107020) Avail: CFSTI CSCL 08K

The current status and role of seismology in society, a forecast of the future role, and recommendations for developing the

technical capability required to meet current and future needs are summarized. Means of attaining the goals of mitigating, predicting, and even preventing earthquakes are described, as well as increased investigation of the earth's crust and deep interior. The capabilities of the future observational and laboratory facilities, and the research and training facilities at universities are outlined. Some of the uses of seismology are identified and as exploration of underwater, oil, and mining resources, and state and federal interests are reviewed. Graduate students and graduate programs, and federal funding in seismological research are also covered. N.E.N.

N70-12423# Oak Ridge National Lab., Tenn.
PHYSICS, THERMAL HYDRAULIC, AND FUEL CYCLE COST ANALYSES OF A METALLIC URANIUM DIRECT REPLACEMENT FOR PWR'S
F. G. Welfare and J. E. Jones 11 Jul. 1969 40 p refs
(ORNL-TM-2493) Avail: CFSTI

The Diablo Canyon pressurized water reactor is analyzed with the oxide fuel replaced by annular metal pins. Thermal-hydraulic, physics, and fuel-cycle economics analyses are presented. The results show possible savings of up to .3 mills per kilowatt hour electric in fuel cycle costs. The possible effects of uncertainties in physics results, physics procedures, and fuel element performance are considered. The effect of these uncertainties may be to reduce the saving in fuel cycle cost to less than .1 mill per kilowatt hour electric. Perhaps the most significant result is that the metal fueled systems have the potential for shaprly reducing the separative work and ore requirements for an industry of pressurized water reactors. Author (NSA)

N70-12921# Geological Survey, Denver, Colo.
POTENTIAL APPLICATIONS OF NUCLEAR EXPLOSIVES TO THE RECOVERY OF GEOTHERMAL ENERGY Progress Report for Fiscal Year 1966
Howard H. Waldron Jun. 1969 20 p refs *Its* Geothermal Energy-1
(Contract AT(04-3)-289)
(USGS-289-1) Avail: CFSTI

The initial phase of study and the utilization of nuclear explosives for stimulating and beneficiating the recovery of geothermal energy have been directed toward fundamentals that may control or influence the occurrence and character of geothermal areas. Some characteristics of heat flow and of geothermal districts are summarized; the occurrence and distribution in the United States of the more than 1,300 thermal spring localities, indicative of geothermal districts, are reviewed. Future work will include broad regional studies in the Western United States, and detailed studies of one or more selected geothermal districts. Author (NSA)

N70-13396# Idaho Nuclear Corp., Idaho Falls. National Reactor Testing Station.
SUBASSEMBLY TEST PROGRAM OUTLINE FOR FY 1969 AND 1970
J. E. Grund, R. L. Johnson, K. O. Johnson, R. W. Miller, R. T. Johnson et al Aug. 1969 175 p refs
(Contract AT(10-1)-1230)
(IN-1313 ; IDO-17277) Avail: CFSTI

The subassembly test program in the Spert 4 capsule driver core for FY 1969 and 1970 is outlined. Basic program objective is to provide the AEC and reactor vendors with experimental information on reactor fuel behavior under transient overpower conditions. Test plans for unirradiated and irradiated (burnups to 30,000 MWd/T) UO2 fuels, Pu recycle fuels, and LMFBR fuels are presented. Data of particular interest include failure modes and thresholds, conversion efficiencies of nuclear-to-mechanical energy, transient pressures, and metal-water reaction extents, all as functions of transient energy deposition for a variety of fuel design parameters, burnup, and environmental conditions. Author (NSA)

N70-14088# Lamar-Merifield, Santa Monica, Calif.
GEOLOGICAL INFORMATION FROM SPACE PHOTOGRAPHY
Paul M. Merifield *In* Calif. Univ. Remote Sensing of the Environ. Aug. 1968 27 p refs
Avail: CFSTI

The usefulness of high altitude photography in geologic studies is discussed, and several photographs and television images taken from above the atmosphere are analyzed to furnish an idea of the type of information recorded by them. Some aspects of satellite photogrammetry that are applicable to image interpretation are treated subsequently. The most complete coverage of the surface is in the form of TV pictures, but such photographs are less useful from a geologic standpoint owing to their lower resolution. One of the primary geological contributions of hyperaltitude photography is in identifying petroleum and mineral resources in unexplored or inadequately explored regions which are characterized not only by lack of geologic information but also of map and photographic coverage. It is emphasized that about 50% of the earth's surface is inadequately or completely unphotographed from the air, with most concentration being in North America and Europe. Satellite-borne cameras would yield photos with scales of about 1:2,000,000 to 1:250,000 from a 200-mile altitude; such small scale photos and maps made from them would be useful during the planning and reconnaissance stage of mineral and petroleum exploration. A.C.R.

N70-14123# Idaho Nuclear Corp., Idaho Falls. Reactor Engineering Branch.
CRITICAL FACILITIES
In its Reactor Eng. Branch Feb. 1969 p 115-147

Avail: CFSTI

Increasing reactor coolant temperature had only a small effect on shim and safety rod worths; however, the outer shim worths increased significantly when the experiment loop temperatures were raised. Measurements in typical ATR experiment irradiation positions show that fast neutron flux and gamma heating can be predicted from low power measurements in the ATRC within 5 and 20%, respectively. The power spectral density, from zero-power noise measurements, shows prominent resonances attributed to flow-induced vibrations of the in-pile experiment tubes. Power distribution measurements in the ATRC show that the core hot-spot power generation can be reduced 18% by using radially zone-loaded fuel elements, without affecting the fission rate in adjacent loop experiments. Author (NSA)

N70-14317# California Univ., Livermore. Lawrence Radiation Lab.
RADON DAUGHTER EQUILIBRIUM MEASUREMENTS IN URANIUM-MINE ATMOSPHERES
C. L. Lindeken *In its* Hazards Control Dec. 1968 p 34-38 refs Sponsored by AEC
Avail: CFSTI

When radon gas formed for radioactive decay of uranium escapes from exposed ore surfaces and enters the mine atmosphere, a series of short-lived daughter products is formed and becomes a potential hazard to mine workers. In an unventilated mine or in a section of the mine that is poorly ventilated, these daughter products will accumulate and will approach equilibrium with radon. Various methods for measuring radon daughter equilibrium are discussed. A prototype plutonium alpha air monitor using a 450 sq mm surface-barrier silicon diode is described for determining this radon daughter equilibrium. Author (NSA)

N70-15236# Gulf General Atomic, San Diego, Calif.
NEUTRON ACTIVATION ANALYSIS INDENTIFICATION OF THE SOURCE OF OIL POLLUTION OF WATERWAYS
V. P. Guinn and S. C. Bellanca *In* Natl. Bur. of Std. Mod. Trends

in Activation Analysis, Vol. 1 Jun. 1969 p 93-97 refs

(Contract AT(04-3)-167)
Avail: SOD $8.50

This paper is concerned with a method of determining the origin of a given pollution event in which fresh water, brackish water or sea water is polluted – accidentally or intentionally – by heavy oil (crude oil or heavy fuel oil). The method employed in this exploratory study was that of trace-element characterization via purely instrumental neutron activation analysis (NAA). In these exploratory measurements, 16 different marine fuel oils were analyzed by NAA, and their V, Mn, Na, Co, Sb, As, Cu, and Zn levels compared. The effects of prolonged contact with sea water and with fresh water upon these trace-element concentrations was also explored. The results indicated clearly the possibility of NAA trace-element characterization of oil-slick samples. Author

N70-16280# Institute of Nuclear Techniques, Krakow (Poland).
ON THE FEASIBILITY OF THE DETERMINATION OF WATER, SALT AND SULPHUR IN CRUDE OIL BY MEANS OF NEUTRON ACTIVATION ANALYSIS
L. Gorski, J. Janczyszyn, and L. Loska *In* Natl. Bur. of Std. Mod. Trends in Activation Analysis, Vol. 1 Jun. 1969 p 420-429 refs
(Contract IAEA-375/RB)
Avail: SOD $8.50

Contaminations of crude oil can be determined by means of activation analysis with 14 MeV neutrons. The contents of the particular contaminants in crude oil imported by Poland are the following: NaCl contents: small – 25 mg/liter, average – 250 mg/liter; exceptionally high – 1500 mg/liter; H2O average – 6 g/liter; S average – 15 g/liter. Continuous determination of these contaminations can be carried out. Author

N70-16491*# New Mexico Univ., Albuquerque. Technology Application Center.
[ACTIVITIES OF TECHNOLOGY APPLICATION CENTERS] Quarterly Status Report, Jul. – Sep. 1969
Sep. 1969 31 p
(Contract NSR-32-004-049)
(NASA-CR-107560) Avail: CFSTI CSCL 05B

User activity, marketing, and dissemination operations of the natural resources and industrial programs are summarized, along with the economic status and organizational changes at the information center. Steps were taken to provide quality photograph reproductions in reduced turn-around time. The EDN Caravan tour to publicize the technical utilization program is briefly discussed. J.A.M.

N70-16407*# Michigan Univ., Ann Arbor. Infrared and Optics Lab.
FURTHER INFRARED SYSTEMS STUDIES FOR THE EARTH RESOURCES PROGRAM Final Report
J. Braithwaite, L. Larsen, and E. Work Dec. 1969 77 p refs
(Contract NAS9-8381)
(NASA-CR-102111; WRL-2122-14-F) Avail: CFSTI CSCL 14B

This report discusses the development of design concepts and specifications for multispectral scanners for use from orbit as part of the Earth Resources Program. The performance of such scanners may be limited by component performance, by weight and power allocations, and by the data rates and bulks which can be returned to the ground. Some of the more critical of these factors have been examined in detail, and methods of dealing with them have been investigated. It is shown, for example, that a 7-channel scanner with a 200 ft ground resolution is feasible, but that the swath width would be limited to less than 20 miles unless telemetry bandwidths larger than those in current use are made available. Author

N70-16584# Akademiya Nauk URSR, Kiev.
THERMOPHYSICS AND THERMOENGINEERING: MINING THERMOPHYSICS
V. I. Tolubinskij ed. 1968 124 p refs In RUSSIAN
Avail: CFSTI

CONTENTS:

N70-16585# Akademiya Nauk URSR, Kiev.
PRACTICAL APPLICATION OF UNDERGROUND HEAT SOURCES
V. Ya. Zhuravlenko, A. V. Shurchkov, and E. R. Grosman *In its* Mining Thermophysics 1968 p 7-14 refs In RUSSIAN

Avail: CFSTI

Engineering and economic indicators are reviewed on the use of subsurface thermal waters in heat supply and power generating systems. An artifical circulation system is proposed for

heat transfer from subsurface porous layers using underground boilers. Preliminary calculations for this system are given. E.C.

N70-16586# Akademiya Nauk URSR, Kiev.
PROSPECTS FOR THERMAL WATER EXPLORATION IN TRANSCARPATHIAN REGION OF UKRANIAN SSR
I. A. Mesyets, B. A. Kotyk, and L. P. Myshkin *In its* Mining Thermophysics 1968 p 15–18 In RUSSIAN

Avail: CFSTI

Geothermal conditions and thermal water distribution resources within the Transcarpathian region are discussed. Sites most promising for thermal water prospecting operations are specified. Transl. by E.C.

N70-16587# Akademiya Nauk URSR, Kiev. Ukrgeofizrazvedka Trust.
RESULT OF GEOTHERMAL MEASUREMENTS IN DEEP BOREHOLES OF PETROLEUM-BEARING REGIONS OF THE UKRAINE
A. A. Potushanskij *In its* Mining Thermophysics 1968 p 19–24 refs In RUSSIAN
Avail: CFSTI

Temperature measurements in deep boreholes are summarized. Temperatures higher than 100 C were recorded in ten boreholes. Predicted temperatures for rocks are given for depths up to 7000 meters. The potential of the petroleum-bearing regions of the Ukraine as a plentiful source of thermal energy is emphasized. Transl. by E.C.

N70-16588# Akademiya Nauk URSR, Kiev.
FILTRATION OF HEAT CARRIERS IN EARTH CORE ROCKS AT A DEPTH OF FROM 6 TO 8 KILOMETERS
V. S. Gorbenko, V. P. Ponomarev, and A. I. Fialko *In its* Mining Thermophysics 1968 p 25–30 refs In RUSSIAN

Avail: CFSTI

Crack characteristics in rocks at depths of from 6 to 8 kilometers are examined. Results of theoretical and experimental investigations support the feasibility of constructing an 'underground boiler' system for generating thermal energy at these depths. A reliable filter system for heat conductors is also considered. Transl. by E.C.

N70-16589# Akademiya Nauk URSR, Kiev.
PRESSURE EFFECTS ON FILTRATION OF A HEAT CARRIER IN EARTH CORE ROCKS
A. S. Tsyrulnikov and A. I. Fialko *In its* Mining Thermophysics 1968 p 31–35 refs In RUSSIAN
Avail: CFSTI

Laboratory measurements of pressure effects on the permeability of rocks are reviewed. Results are given for comprehensive external pressure measurements on 8 sandstone-type and 4 close-grained metamorphized rocks with permeability levels of from 1.78 m-darcy to 20 darcy. Pressures ranged between 25 and 600 atm. A non-polar purified kerosene liquid filter was used. The porosity, density, and pore structure of the rocks was also determined. A formula is derived for calculating permeability variations in rocks due to applied pressure. Transl. by E.C.

N70-16590# Akademiya Nauk URSR, Kiev.
CALCULATIONS ON BOILER APPARATUS FOR EXPLOITING SUB-SURFACE HEAT SOURCES
A. V. Shurchkov *In its* Mining Thermophysics 1968 p 36–40 refs In RUSSIAN
Avail: CFSTI

A formula is proposed for estimating optimized annual costs of a geothermal installation for exploiting underground heat sources. Parameters considered include the number of boreholes, their depth, and temperature drop measurements. Cost estimates for mining operations would be calculated interms of the annual output of thermal energy. Data on deductions from capital outlay for equipment, maintenance costs, and expenditures for the electrical energy to power the heat transfer circulation system would be included in the calculations. Transl. by E.C.

N70-16595# Akademiya Nauk URSR, Kiev.
CALCULATING THE INDEX OF ENDOGENIC INFLAMMABILITY ON THE BASIS OF HEAT TRANSFER AND THERMOCHEMICAL PROCESSES
Kh. A. Bayev *In its* Mining Thermophysics 1968 p 73 78 refs In RUSSIAN
Avail: CFSTI

The inflammability of coal deposits can be calculated for warning of endogenic fires in coal mines. Fire hazards are usually evaluated by the tendency of coal to spontaneous combustion (chemical activity), which is related to the capacity of coal for oxidation and heat liberation. However, this evaluation often does not correspond to the actual fire hazard, because spontaneous combustion is a very complex process in which other factors, such as the size of the coal seam, air flow, conditions of heat transfer to the surrounding medium, etc., play a significant role in addition to chemical activity. Under certain conditions a combination of several factors causes spontaneous combustion of coal even with little chemical activity. Differential equations are derived for calculating some of these facotrs, and the heat transfer and thermochemical processes of spontaneous combustion of coal are considered. Transl. by R.B.

N70-17649# Atomic Energy Commission Research Establishment, Lucas Heights (Australia).
THE PRODUCTION OF NUCLEAR GRADE URANIUM DIOXIDE POWDERS FROM AUSTRALIAN ORES
P. G. Alfredson 19 Mar. 1969 19 p refs Conf. held at the Australian Inst. of Mining and Met., Sydney, 10-15 Aug. 1969 *Its* Paper No. 3
(CONF-690815-3) Avail: CFSTI

Power reactors using natural uranium dioxide fuel are of special interest to countries such as Australia that have their own uranium supplies. A wide range of uranium dioxide powders can be fabricated and the ideal one flows readily, presses without the need for binders or lubricants, sinters to the required density, and gives low reject rates at all fabrication stages. Details are given of the dissolution, solvent extraction, preciptation, filtration, drying, and calcination-reduction steps. Solvent extraction from sulphate media is also under study with a view to developing a process to produce a nuclear grade product at the mine treatment plant site. Author (NSA)

N70-19219# Atomic Energy Commission, Washington, D.C. Div. of Reactor Development and Technology.
USE OF THORIUM IN NUCLEAR POWER REACTORS
Jun. 1969 144 p refs
(WASH-1097) Avail: SOD $1.25

A review of the potential use of Th in power reactors is presented. Different reactor types are analyzed for Th fuel cycles. Characteristics of Th fuel cycles are described. Cost factors and long-range fuel demands and requirements are analyzed for power reactors. Design parameters for a conceptual 1000 MW(e) molten salt breeder reactor are presented. NSA

N70-19586# Argonne National Lab., Ill.
CHEMICAL ENGINEERING DIVISION Annual Report, 1968
Apr. 1969 180 p refs
(Contract W-31-109-eng-38)
(ANL-7575) Avail: CFSTI

Experimental studies in nuclear chemistry and thermochemistry for the improvement of reactor fuels are presented. The areas

covered include: fluidization and volatility process, energy conversion, determination of burnup of fast reactor fuels, materials chemistry and thermodynamics, compact pyrochemical processes, reactor safety, and nuclear constants. J.M.C.

N70-20121 National Lending Library for Science and Technology, Boston Spa (England).
THE URANIUM/THORIUM CYCLE PROGRAMME
22 Oct. 1969 7 p Transl. into ENGLISH from Comit. Naz. Energia Nucl. Notiziario (Rome), May 1968 p 64-67
(NLL-RISLEY-Trans-1783-(9091.9F)) Avail: Natl. Lending Library, Boston Spa, Engl.: .1 NLL photocopy coupons

The plans to investigate the technical and economic possibilities of the U/Th cycle and to study the technology in reprocessing irradiated fuel and fuel element refabrication are briefly described. The fissile material recovered from the reprocessing of the second third of the Elk River core will be used to make driver charge elements of the Halden heavy water reactor. The possibility of reprocessing fuel elements from a prototype HTR reactor is mentioned, and the costs of the program are tabulated. N.E.N.

N70-20349 National Lending Library for Science and Technology, Boston Spa (England).
LEAK TESTING OF CONTAINERS AND CAPSULES FOR RADIO-ACTIVE MATERIALS
H. Kowalewsky et al 17 Dec. 1969 8 p Transl. into ENGLISH from Material Pruefung: (Duesseldorf), v. 11, no. 10, 1969 p 345-347
(NLL-RISLEY-Trans-1865-(9091.9F)) Avail: Natl. Lending Library, Boston Spa, Engl.: .1 NLL photocopy coupons

Safety regulations governing the transportation of radioactive materials are discussed along with special leakage tests for packages and capsules for high activity materials and nuclear fuels. Pressure rise, helium leak, and radioactive dip tests are described and compared for efficiency in the determination of possible leaks. Results indicate that the helium leak test is by far the most accurate process. J.M.C.

N70-20596 National Lending Library for Science and Technology, Boston Spa (England).
CONTINUOUS TESTING IN THE MARCOULE PLANT
J. Chabert et al [1969] 6 p Transl. into ENGLISH from Bull. d'Inform. Sci. et Tech. (France), no. 140, Sep. 1969 p 23-26
(NLL-RISLEY-Trans-1866-(9091.9F)) Avail: Natl. Lending Library, Boston Spa, Engl.: .1 NLL photocopy coupons

The continuous testing system of Marcoule chemical plant for irradiated fuel treatment is reviewed emphasizing the advantages of economy, safety, and regulation. Classical continuous testing of temperature, density, flow rate, and pH is evaluated, along with radio chemical measurements including alpha particles, gamma emission, and neutron irradiation. J.A.M.

N70-20779 National Lending Library for Science and Technology, Boston Spa (England).
NEW ABSORBENTS AND CLASSIFICATION OF METHODS OF REMOVING SULPHUR DIOXIDE FROM INDUSTRIAL GASES [NOVYE POGLOTITELI I KLASSIFIKATSIYA SPOSOBOV OCHISTKI PROMYSHLENNYKH GAZOV OT DVUOKISI SERY]
A. M. Nagiev et al Nov. 1969 5 p refs Transl. into ENGLISH from Izv. Vyssh. Ucheb. Zaved., Neft. i Gaz. (USSR), no. 11, 1968 p 108-110
(NRLL-RTS-5464) Avail: Natl. Lending Library, Boston Spa, Engl.: 7s 6d or 1 NLL photocopy coupons

Liquid petroleum products were investigated for their ability to absorb sulfur dioxide. Experiments show that sulfur dioxide is absorbed as a result of chemical reaction with hydrocarbon compounds. Petroleum products which absorb sulfur dioxide become much lighter in color and different products have different absorption capacities. Classification methods are given for ways of extracting sulfur dioxide from waste gases. R.B.

N70-21010# Kyoto Univ. (Japan). Research Reactor Inst.
RESEARCH ON RADIOACTIVE DUST IN THE AIR AT KUR OPERATION
Akihiko Negoro, Koichi Sekiya, Tsujimoto Hirotoshi, Yoshii Tadashi, Giichi Yoshii et al [1968] 6 p refs In JAPANESE; ENGLISH summary
(KURRI-TR-56) Avail: AEC Depository Libraries

Investigations were carried out on the radioactive dust which might have been produced when KUR reactor operated. According to the results, the radioactive dusts produced in the course of operation of the KUR reactor may be divided into two kinds: the dust that may be originated from the fission production of the fuel; and the other, being the aerosols activated. The former, compared with the latter, is produced in greater quantity. Moreover, such a quantity appears to depend largely on the specific kind of fuel used and the time length of operation. Author (NSA)

N70-21080 National Lending Library for Science and Technology, Boston Spa (England).
DEVELOPMENT OF OXIDE SYSTEM FUELS
Yasuji Nakamura 17 Dec. 1969 22 p Transl. into ENGLISH from Genshi Ryoku Kogyo (Tokyo), v 14, no. 8, 1968 p 19-24
(NLL-DOURREAY-TRANS-419-(9091.9F)) Avail: Natl. Lending Library, Boston Spa, Engl.: 2 NLL photocopy coupons

The development of fast reactor mixed oxide fuels for use in Japan is reviewed, and the power output, and high temperatures of the fast reactor cores are discussed. It is shown that an overall heat generation of from 500 to 700 kw per 12 of reactor core occurs. The research and development accomplished since the work started are reported in the following areas: (1) requirements in development of manufacturing techniques, (2) manufacturing processes, (3) costs, (4) assembly design and erection, and (5) irradiation tests. A table comparing the manufacture of PuO2-UO2 pellet fuels by the co-precipitation method to the mechanical mixing method is included. F.O.S.

N70-21251# Sandia Corp., Albuquerque, N. Mex.
TRANSIT ANALYSIS
J. R. Holland, C. J. M. Northrup, Jr., W. A. Stark, and D. C. Williams Oct. 1969 35 p refs
(SC-RR-69-662) Avail: CFSTI

The helium release from Pu(238)O2 microsphere fuel was calculated for six different heat-sources that have been proposed for the transit radioisotope thermoelectric generator. The release mechanism was assumed to be classified diffusion, with a two-term, temperature-dependent diffusion coefficient. The temperature history assumed was based upon contractor-supplied information. Two different methods of approach were used and the results were compared. Helium release was calculated both for the normal mission profile and for various possible aborts. Upper and lower limits for the release were also calculated. The origins and nature of the rather sizable uncertainties involved are discussed. Author (NSA)

N70-21969# Societa Ricerche Impianti Nucleari, Saluggia (Italy).
PRESENT STATUS OF INVESTIGATIONS ON THE HEAT TRANSFER PROBLEMS OF THE EARTH BURIAL OF SPACE RADIOISOTOPE HEAT SOURCES
A. Campanile Sep. 1969 23 p refs
(Contract CNEN-ELDO/CTR/17/6/17)
(SORIN-T/601) Avail: CFSTI

This report deals with the problem of intact reentry of space radioisotope heat sources. The first impact phase is specially treated, with specific reference to land impact and heat dissipation problems under burial conditions. ESRO

N70-23046# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
PETROLEUM PRODUCTS, PROPERTIES, QUALITY, APPLICATION, PART 1 APPLICATION, PART 2
B. V. Losikov 22 Aug. 1969 236 p refs Transl. into ENGLISH from the Russian Report
(AD-698440; FTD-HT-23-347-68-Pt-1) Avail: CFSTI CSCL 21/4

The handbook presents data concerning the properties, quality, and application of petroleum products: liquid fuels and oils, lubricants, paraffin, bitumen, special oils, solvents, etc. Each chapter includes tables and diagrams of a particular products properties, conditions for use, and efficiency. The first section contains chapter 1-3 which cover: Fuels for spark-ignition piston engines; Fuels for air-breathing reaction (jet) engines; and Diesel fuels. TAB

N70-23047# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
PETROLEUM PRODUCTS, PROPERTIES, QUALITY APPLICATION, PART 1 APPLICATION, PART 2
B. V. Losikov 22 Aug. 1969 232 p refs Transl. into ENGLISH from the Russian Report
(AD-698546; FTD-HT-23-347-68-Pt-2) Avail: CFSTI CSCL 21/4

The document contains Chapters 4-6 of a Russian handbook of petroleum products. These chapters discuss fuel additives (antiknock, storage, corrosion), motor oils, and boiler fuels. TAB

N70-23048# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
PETROLEUM PRODUCTS, PROPERTIES, QUALITY, APPLICATION, PART 3
B. V. Losikov 22 Aug. 1969 200 p refs Transl. into ENGLISH from the Russian Report
(AD-698547; FTD-HT-23-347-68-Pt-3) Avail: CFSTI CSCL 11/8

The document contains Chapters 7-10 of a Russian handbook of petroleum products. These chapters discuss drive-train oils, lubricating oils for aviation gas-turbine engines, industrial oils, and insulating oils. TAB

N70-23049# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
PETROLEUM PRODUCTS, PROPERTIES, QUALITY, APPLICATION, PART 4
B. V. Losikov 22 Aug. 1969 237 p refs Transl. into ENGLISH from the Russian Report
(AD-698548; FTD-HT-23-347-68-Pt-4) Avail: CFSTI CSCL 11/8

The document contains Chapters 11 and 12 of a Russian handbook of petroleum products. These chapters discuss oil additives (viscosity, antioxidants, anticorrosion, detergents, antifoams) and lubricants. TAB

N70-24796# Joint Publications Research Service, Washington, D.C.
TERRESTRIAL GEOPHYSICS
In its Soviet-Bloc Res. in Geophys., Astronomy, and Space, No. 221 2 Feb. 1970 refs p 74–90 (See N70-24792 11-34)
Avail: CFSTI

The oil drilling rig at Shevchenkovo, a seven kilometer exploratory well, is described. Abstracts on a wide spectrum of geophysical data are included. J.A.M.

N70-25326 West Virginia Univ., Morgantown.
INFLUENCE OF ULTRASONIC ENERGY UPON THE RATE OF FLOW OF LIQUIDS THROUGH POROUS MEDIA
Wong-I Chen (Ph.D. Thesis) 1969 141 p
Avail: Univ. Microfilms: HC $6.80/Microfilm $3.00 Order No. 69-20702

The effects of ultrasonic energy upon the flow rate of crude oil through porous sandstone and the effect of water flow through a porous stainless steel filter were investigated. When acoustic energy with a frequency of 20,000 cycles per second was introduced, there was a substantial increase in the rate of liquid flow through both of the porous mediums tested. The investigation made use of an oil bearing sandstone which had a porosity of 20 per cent with a pore diameter of approximately 25 microns. In the first series of runs, three thicknesses of sandstone were used 0.5, 1.0 and 2.0 centimeter. These runs were conducted at atmospheric pressure. A second series of runs were made placing the whole system under pressure. Pressures up to 80 psig were used. For the runs made at atmospheric pressure, the addition of ultrasonic energy increased the oil flow rate approximately two to nine times depending upon the thickness of the sandstone used.
Dissert. Abstr.

N70-28685# Bureau of Mines, Bartlesville, Okla.
COMPARATIVE EMISSIONS FROM SOME LEADED AND PROTOTYPE LEAD-FREE AUTOMOBILE FUELS
B. H. Eccleston and R. W. Hurn May 1970 28 p refs
(BMRI-7390) Avail: CFSTI

The effect upon automobile emissions in changing from leaded to lead-free gasolines was studied. Typical U.S. leaded gasolines and prototype lead free gasolines of comparable octane quality were used in eight vehicles operated to simulate city driving. The experiments were run at 70 and 95 F. Exhaust and evaporative emissions were measured and the photochemical effect of the emissions was experimentally observed in an artificial smog chamber. Results reveal the manner and degree in which the changes in fuel composition alter the amount and characteristics of both exhaust and evaporative emissions. It is shown that the compositional differences between leaded and prototype lead free fuels resulted in higher photochemical pollution potential of the emissions from the lead free fuels. The effect is attributed to the photochemical characteristics of high octane fuel components that are used in greater quantity in the lead free fuels. Author

N70-28899# California Univ., Lawrence Radiation Lab.
MIRROR SYSTEMS: FUEL CYCLES, LOSS REDUCTION, AND ENERGY RECOVERY
R. F. Post 8 Sep. 1969 51 p refs Presented at the Intern. Conf. on Nucl. Fusion Reactors, Culham, England, 17-19 Sep. 1969 Supported by AEC
(UCRL-71753; Conf-690901-7) Avail: CFSTI

The problem of maximizing the usable fusion energy from mirror-confined plasmas is considered. Two approaches are emphasized, as follows: (1) optimization of the fusion energy release by adjustment of the fuel plasma composition, ion temperature and operating cycle, together with exploitation of neutron-multiplying reactions in the blanket, and (2) employment of direct energy recovery techniques to improve injection efficiency and to recover energy in electrical form from the end loss particle flux. Approach (1) using DT reactions, followed by neutron multiplication and capture in sodium or aluminum is predicted to lead to steady state energy releases of about 30 to 35 MeV per reaction, depending on the tritium breeding ratio is required. With a modified DD cycle, where breeding is not required, total energy releases of about 15 MeV per deuteron should be obtainable by a similar technique.
Author (NSA)

N70-29067# Steinkohlen-Elektrizitaet AG, Essen (West Germany).
WATER-SUSPENDED COAL SUPPLY TO THERMAL POWER PLANTS [VERSORGUNG THERMISCHER KRAFTWERKE MIT STEINKOHLE/WASSER-SUSPENSION UEBER ROHRLEITUNGEN]
Heinrich Merten (Ph.D. Thesis—Tech. Hochschule, Darmstadt, West Ger.) Darmstadt, West Ger. Tech. Hochschule 4 Jul. 1969 110 p refs In GERMAN
Avail: CFSTI

Measurements were made of the frictional pressure losses in four horizontal pipelines of different diameters, transporting coal/water suspensions in a wet grinding installation. It was concluded that deposit-free pipeline transport was only possible over longer periods in the turbulent flow range. Author (ESRO)

N70-33032# Atomic Energy Commission Research Establishment, Lucas Heights (Australia).
NUCLEAR FUEL AND MATERIALS (U, BE, ZR) FOR REACTOR
Yoshitsuga Mishima Feb. 1970 17 p Transl. into ENGLISH from Kogyo Reametaru (Tokyo), no. 39, Sep. 1968 p 19–22 In ENGLISH and JAPANESE
(LIB/TRANS-240) Avail: AEC Depository Libraries

In the power generation program made public in January 1968 it was announced that the Japanese nuclear power installation would be generating 6.93 million kW by the end of 1975. Uranium ore was secured as much as 58% of the necessary amount up to 1978. The supply of U for the Tokai power station and the reproduction of used fuel were guaranteed by Great Britain; and the private ownership of nuclear fuel, the enriching service of 161 tons of U, and the procurement of 365 kg of Pu for research and development were guaranteed by the U.S.A. In order to prepare for the start of operation of nuclear power plants, standards relating to the transporting vessel for nuclear fuel and the criteria for inspections were drawn up. The qualitative problems of domestically produced fuel for the light water reactors were almost solved. The prototype conversion reactor with 200,000 kW output was scheduled to reach criticality in 1974. The fast breeder reactor fuel were to be produced in Japan. A decline of ductility in a beryllium alloy sheath tube due to helium damage was analyzed. A 901 kg rectangular bar of Be was used for the reflector in the material testing reactor JMIR. Author (NSA)

N70-34002# Mc Donnell-Douglas Co., Long Beach, Calif.
ECONOMIC ANALYSIS OF THE USE OF GELLED FUELS IN JET TRANSPORT AIRCRAFT Final Report
H. D. Whallon, A. T. Peacock, and L. D. Christensen Jul. 1970 64 p refs
(Contract FA-68-NF-273)
(FAA-NA-70-45; FAA-DS-70-13) Avail: CFSTI

A previous study examined the technical aspects of using gelled or emulsified fuel in a DC-8-62 commercial jet transport and identified associated problems. This study examined the economics of jet fleet conversion to the use of 2 percent gelled fuel. Based on the technical findings, a DC-8-62 analysis, it was estimated that conversion and operation for the ten years 1972-81 of all U.S. air carrier jet passenger airplanes would add about four billion dollars to their operating costs for the decade. This is approximately a 4.5 percent increase to total operating costs. Author

N70-35477# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
MOSCOW. ALL-UNION SCIENTIFIC RESEARCH INSTITUTE FOR PETROLEUM REFINING. TRANSACTIONS
1 Oct. 1969 114 p refs Transl. into ENGLISH from Tr. Vses. Nauch.-Issled. Inst. po Pererabotke Nefti (Moscow), no. 10, 1967 p 154 159, 163 205, and 299 332
(AD-700689; FTD-HT-23-277-69) Avail: CFSTI CSCL 11/8

Contents: Potentiometric method for determining base numbers of additives and oils containing additives; Radio indicator method for studying detergent and antioxidant properties of engine oil additives; Method of studying sizes and charges of particles formed by detergent additives in motor oils; Method for thermographic examination of lubricating oil antiseizing additive stability and reactions with metals; Radio indicator method for examining the chemical activity of antiseizing additives at 200 - 600C in the oil-metal contact zone; Radio indicator method of examining the reaction mechanism of organomolybdenum oil additives; Application of solid lubricant material to friction surfaces; Apparatus and method for comparative evaluation of wear on solid lubricant surfaces; Evaluation of wearability and antifriction properties of solid lubricant coatings on the MI machine; Evaluation of the stability of oils and greases in the rolling friction zone; and Apparatus for determining high-temperature grease drop-forming temperatures. TAB

N70-37284# United Kingdom Atomic Energy Authority, Risley (England). Reactor Group.
HIGH-TEMPERATURE REACTOR
N. H. Mc Laren Apr. 1970 15 p refs
(TRG-Rept-1996) Avail: AEC Depository Libraries

In the U. K. the helium cooled high temperature reactor is known as the Mark III GCR, Mark I and II being the Magnox and AGR designs, respectively. The development of the reactor engineering and of the fuel is described. A description of a typical Mark III reactor design is given. NSA

N70-37298# Universidad Nacional Autonoma de Mexico, Villa Obregon. Facultad de Quimica.
ENRICHMENT OF URANIUM BY THERMAL DIFFUSION
Concepcion Morales Cruz 1969 61 p refs In SPANISH
(NP-18173) Avail: AEC Depository Libraries

A design for the enrichment of uranium by thermal diffusion is proposed. The design indicates the most convenient equipment and the subsequent operational problems for the enrichment of natural uranium (0.7% of U-235) up to 2.1% U-235. The theoretical results indicate that the operation in principle is simple, and the equipment requirements are very simple and can be easily fabricated in any institution or laboratory of limited resources. The installation is easy and does not require much horizontal space, only a space with sufficient height. For the thermal diffusion design, the temperatures, wire, and the tube were 298 K for the primary and 1073 K for the secondary loops. The electrical power necessary is 1.675 kW. The calculated cost was $8.55/g of UO2. Construction of the thermal columns derived from the theory is under way. NSA

N70-38878# Battelle Inst., Frankfurt am Main (West Germany).
THE IMPORTANCE OF UNCONVENTIONAL METHODS OF ENERGY CONVERSION FOR DEVELOPING COUNTRIES
Klaus Altfelder *In its* Battelle Inform. No. 1 Mar. 1968 p 22–23
Avail: CFSTI

This report discusses the use of nuclear, solar, wind and geothermal power for generating electric power in the 50–1000 kW range in developing countries. ESRO

N70-39139# Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires.
REPROCESSING OF IRRADIATED PLUTONIUM AND URANIUM MIXED OXIDES [LE TRAITEMENT DES OXYDES MIXTES DE PLUTONIUM ET D'URANIUM IRRADES]
P. Faugeras 1969 34 p refs In FRENCH Presented at the 2d Spanish-French Symp. on Fuel Reprocessing and Plutonium Chem., Madrid, Nov. 1969
(CEA-Conf-1534; Conf-691122-3) Avail: AEC Depository Libraries

A study was made on the cost of reprocessing as a function of capacity for the irradiated mixed oxides UO2–PuO2. An amortization rate of 11% corresponding to a period of 17 years and to a rate of interest of 8% was considered. Several possible improvements to be made on the Purex process in order to reduce the reprocessing cost were studied. These are continuous shearing and dissolution; reduction in the number of extraction cycles for the separations of U from Pu; simplification of the conditioning

operations of U and Pu; automation and automatic chemical control, and rational treatment of fission product solutions. The use of a volatilization process should reduce the cost of processing. Small plant units associated with one or several reactors on the same site seem to be still profiting-earning, because of the elimination of transfer and the reduction of plutonium investment. Author (NSA)

N70-39255# Atomic Energy Commission Research Establishment, Lucas Heights (Australia).
SEPARATION NOZZLE DEMONSTRATION PLANT FOR URANIUM ENRICHMENT
E. W. Becker et al [1969] 8 p refs Transl. into ENGLISH from Atomwirtsch., Atomtech. (Duesseldorf), v. 14, May 1969 p 249-251
(NP-TR-1884) Avail: AEC Depository Libraries

In order to make more accurate economic evaluations of the separation nozzle method, development and design studies were undertaken for a pilot plant with a separation output of 600,000 kg U/yr. The plant would supply light water reactors with a total capacity of 6000 MW(e) continuously with fuel. It would cost approximately 300 million DM and consume about 10% of the current produced. It was calculated that the investment costs and the current consumption could be reduced significantly by additional development work. A prototype of the nozzle stages proposed for the pilot plant is under construction. NSA

N70-39314# General Motors Desert Proving Ground, Mesa, Ariz.
TOWARD A CLEANER ENVIRONMENT
John E. Blough *In* Ariz. Univ. Proc. of Air Pollution Control Seminar 13 Feb. 1970 p 4-11
Avail: NTIS

Progress is reported on efforts to eliminate the automobile as a cause of smog, with examples in the Los Angeles area. It is stated that emission controls on new cars are substantially reducing hydrocarbon output. Potential gains which may be realized from reductions in gasoline volatility, removal of tetraethyl lead from automobile gasoline, engine maintenance, and crankcase control devices are suggested. Research and development efforts to reduce carbon monoxide and nitrogen oxide emissions are mentioned. P.A.B.

N70-39640# Labofina Societe Anonyme, Brussels (Belgium).
FUELS FOR SUPERSONIC AIRCRAFT [LES COMBUSTIBLES POUR AVIONS SUPERSONIQUE]
Thierry de Menten de Horne *In* AGARD Fuels, Lubricants, and Auxiliary Fluids for Supersonic and Hypersonic Aviation Jun. 1970 p 29-50 refs In FRENCH
Avail: NTIS

Estimates of fuel consumption in commercial aviation are considered for the years 1960 to 1985. The technical requirements of a fuel are examined, including caloric power provided, weak volatility, thermal stability, combustion characteristics, and behavior at low temperature. The use of additives to correct fuel faults is discussed with relation to the formation of static electricity, fuel stability during storage, microorganism activity in turbine fuels and resulting corrosion, and additives modifying the flow properties of kerosenes. Other solutions proposed for supersonic and hypersonic flights are mentioned, including cryogenic fuels and fuels derived from boron. Transl. by P.A.B.

N70-40779# Federal Aviation Administration, Washington, D.C. Aircraft Development Service.
PROPULSION FUEL SYSTEM FIRE SAFETY
Thomas G. Horeff *In its* Res. and Develop. Rept. to Ind. Jun. 1969 10 p
Avail: NTIS

Research and development progress on aircraft propulsion fuel system fire safety and prevention is presented. Specifically discussed are: (1) tests of liquid nitrogen as a fire extinguishing agent; (2) flame propagation through aircraft vent systems; and (3) thickened safety fuels and fuel system compatibility. Also discussed is the amount of air pollution caused by aircraft and the limitations it may have on the growth of air transportation if precautions are not taken. A.L.

N71-15083# Gulf General Atomic San Diego, Calif.
DEVELOPMENT OF NUCLEAR ANALYTICAL TECHNIQUES FOR OIL SLICK IDENTIFICATION, PHASE 1
D. E. Bryan, V. P. Guinn, R. P. Hackleman, and H. R. Lukens 21 Jan. 1970 134 p refs
(Contract AT(04-3)-167)
(GA-9889) Avail: NTIS

Neutron activation analysis (NAA) has been found to quantitatively measure a large number of trace elements in crude oils and residual fuel oils. Examination of trace element concentrations in oils before and after exposure to wave action, elevated temperature, ultraviolet light, and bacteriological attack demonstrates that the large majority of these concentrations were only slightly affected by a minimal exposure, after which they were stable toward further exposure. Each trace element concentration represents an evidence point for comparison of oil samples, and it was found that there were more than enough stable evidence points determinable by NAA to distinguish between each of 40 different oil samples. Determination of S-34/S-32 of oil specimens reveals that this ratio is another useful evidence point. Author (NSA)

N71-19770# Systems Research Corp., Washington, D.C.
NAVAL SURFACE SHIP ARCTIC MISSIONS. VOLUME 2. APPENDIX A: ARCTIC RESOURCES
L. C. Van Allen, D. M. Tyree, and G. S. Sexton 18 Dec. 1970 128 p refs
(Contract N00014-70-C-0323)
(AD-716415; SRC-70-TR-N3001-Vol-2-App-A) Avail: NTIS CSCL 8/7

Contents: U.S. Arctic resources; (Population, industries, fuel, coal, petroleum, transportation); Canadian Arctic resources; (Population, natural resources, industries, transportation); U.S.S.R. Arctic resources; (Population, industries, fuel, transportation); Scandinavian Arctic resources; and Greenland Arctic resources. GRA

N71-20533*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
CONVERSION OF AN EXPERIMENTAL TURBOJET COMBUSTOR FROM ASTM A-1 FUEL NATURAL GAS FUEL
Francis M. Humenik Washington Mar. 1971 33 p refs
(NASA-TM-X-2241; E-6031) Avail: NTIS CSCL 20M

A side-entry turbojet combustor previously developed with ASTM A-1 fuel was redesigned to use natural gas fuel. The rectangular test section simulated a segment of an annular turbojet combustor. Five combustor liner configurations and two fuel nozzle geometries were evaluated. Natural gas fuel temperatures ranging from -259 to 1200 F were investigated. The test conditions were as follows: nominally atmospheric inlet pressure; inlet air temperature to 600 F; and diffuser inlet Mach numbers of 0.24, 0.30, and 0.37 corresponding to nominal reference velocities of 77, 100, and 120 ft/sec, respectively. The combustor configurations were designed to achieve combustor exit temperatures combustion efficiency and desirable radial exit-temperature profiles having low pattern factors were achieved with only minor combustor modifications. Ignition was readily obtained with natural gas temperatures of -235 F. Author

N71-21050# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
FACTORS AFFECTING THE OPTIMUM FUEL CYCLE

D. E. Deonigi and E. T. Merrill Oct. 1970 14 p Presented at the Regional Meeting of the AIChe, Richland, Wash., 23 Oct. 1970
(Contract AT(45-1)-1830)
(BNWL-SA-3605; CONF-701022-1) Avail: NTIS

Some of the fuel cycle codes which use different techniques for fuel cycle cost calculations are examined. A comparison of the codes shows that the figures used for working capital are responsible for the only variations in the calculated costs. It is shown that a theoretically optimum fuel cycle can be calculated simply by determining the fuel cycle cost resulting from fuel operating to a given exposure without regard to control requirements and system load factors. NSA

N71-21304*# Coast Guard, Washington, D.C. Applied Technology Div.
RESULTS OF OVERFLIGHTS OF CHEVRON OIL SPILL IN GULF OF MEXICO Final Report
Clarence E. Catoe 24 Aug. 1970 20 p refs Sponsored by NASA Original Contains Color Illustrations
(NASA-CR-117497; AD-714681) Avail: NTIS CSCL 14/5

The NASA 927, Earth Resources Aircraft, at Coast Guard request, flew over the Chevron Oil Spill on 16 March 1970, during the day and night. The aircraft was equipped with photographic, infrared, and radar type systems, which collected the data in the oil spill area. Ground truth data during these overflights was collected by Coast Guard personnel and a team of oceanographers from Louisiana State University. The initial data received from NASA, Manned Spacecraft Center was restricted to photographic and 8 to 14 micrometer scanner data. The preliminary analysis of the test results obtained is limited to the above mentioned applicable sensors. Author (GRA)

N71-22717# National Bureau of Standards, Boulder, Colo. Cryogenics Div.
SURVEY OF CURRENT INFORMATION ON LNG AND METHANE AND MEASUREMENTS OF THE THERMOPHYSICAL PROPERTIES OF COMPRESSED FLUID METHANE Annual Progress Report
1 Feb. 1971 91 p refs Sponsored by Am. Gas Assoc., Inc.
(NBS-9781; APR-1; U-204) Avail: Issuing Activity

Research reported includes: (1) a brief summary of the results of a literature survey on liquefied natural gas and methane; (2) a report on the Second International Conference on Liquefied Natural Gas; and (3) a description and summary of studies on the thermophysical properties of compressed fluid methane. Two published research papers on the thermophysical properties studies are presented, along with a manuscript on the preliminary computation of thermodynamic properties of methane. D.L.G.

N71-23499* Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
DECONTAMINATION OF PETROLEUM PRODUCTS Patent
James R. Mosier, inventor (to NASA) Issued 16 Jul. 1968 (Filed 18 May 1965) 2 p Cl. 44-77 Sponsored by NASA
(NASA-Case-XNP-03835; US-Patent-3,393,059; US-Patent-Appl-SN-456874) Avail: US Patent Office CSCL 07C

A description is given of a means and method of effectively controlling bacteria growth in petroleum products, as well as trapping other impurities such as water and solid particles which normally settle to the bottom of stored petroleum products, by the use of a small effective amount of honey.
Official Gazette of the U.S. Patent Office

N71-28159*# Techtran Corp., Glen Burnie, Md.
REFORMING OF GASEOUS HYDROCARBONS INTO TOWN GAS [OMZETTING VAN KOOLWATERSTOFFEN IN STADSGAS]
Jaap Van Willigen (Ph.D. Thesis Technisch Hogeschool, Delft (Netherlands)) Washington NASA Jun. 1971 140 p refs Transl. into ENGLISH from Dutch report
(Contract NASw-2037)
(NASA-TT-F-13668) Avail: NTIS CSCL 13H

The reforming reaction of hydrocarbons with steam is a homogeneous gas phase reaction with an induction period that needs only a thin layer of catalyst to start the reaction. Accordingly, a mixture of hydrocarbons and steam heated to at least 600 C is passed through a thin layer of catalyst, during which passage the reforming starts whereupon the reaction is completed in the empty reactor chamber above the catalyst. The need for heat for the endothermic reaction may be met by external heating, but also by adding air or oxygen to the gas mixture. Author

N71-29603*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
PROCEEDINGS: SPACE TRANSPORTATION SYSTEM PROPULSION TECHNOLOGY CONFERENCE. VOLUME 3: AUXILIARY POWER UNIT AND AIRBREATHING PROPULSION
28 Apr. 1971 161 p Conf. Held at Huntsville, Ala. 6–7 Apr. 1971
Avail: NTIS CSCL 21H

CONTENTS:

1. AUXILIARY POWER UNIT: INTRODUCTION D. G. Beremand (NASA, Lewis Res. Center, Cleveland, Ohio) p 1097–1098
2. AUXILIARY POWER UNIT DESIGN STUDIES W. L. Burriss and M. L. Hamilton (AiResearch Mfg., Co., Los Angeles, Calif.) p 1099–1122)
3. AUXILIARY POWER UNIT DESIGN STUDIES R. S. Siegler (Rocketdyne, Canoga Park, Calif.) p 1123–1190
4. H2 FUEL SYSTEM INVESTIGATION W. Collier (GE, Philadelphia, Pa.) p 1191–1224
5. BOOSTER AND ORBITER ENGINE STUDIES H. G. Moore (Pratt and Whitney Aircraft, West Palm Beach, Fla.) p 1225–1255

N71-29852# Atomic Energy Commission, Washington, D.C.
ENERGY SOURCES OF TOMORROW
W. E. Johnson *In its* Proc. of the 11th AEC Air Cleaning Conf., Vol. 2 Dec. 1970 p 459–466
Avail: NTIS HC$6.00/MF$0.95

The energy required in the USA in the future to keep the environment habitable for an expanding population and the relation between our environment and energy are discussed. It is concluded that 6 times the present electric energy capacity will be needed by the year 2000 to clean the environment and to maintain a reasonable standard of living for the additional population. Methods must be found for producing, distributing, and both cleanly and economically using fossil fuels. The more efficient breeder reactors must be developed for the economic use of nuclear fuels in commercial power plants. Finally, a nationally coordinated system for planning, developing, constructing, fiancing, and operating power plants is needed to achieve both the future electric energy needs and the environmental compatibility requirements. NSA

N71-29878# Northeastern Radiological Health Lab., Winchester, Mass.
INVESTIGATION OF A NUCLEAR FUEL REPROCESSING PLANT UPON ITS ENVIRONMENT
D. G. Smith *In* AEC Proc. of the 11th AEC Air Cleaning Conf., Vol. 2 Dec. 1970 p 832–836
Avail: NTIS HC$6.00/MF$0.95

To prevent unnecessary expenditures on hastily conceived environmental sampling and monitoring programs around the several

planned nuclear fuel reprocessing plants, a project for development of a recommended methodology to enable agencies to carry out their responsibilities economically and accurately with a minimum of cost or inconvenience to the operators of these facilities is suggested. The objectives of this study are: To develop minimum and optimum requirements for environmental surveillance programs around nuclear fuel reprocessing plants; to develop a uniform set of surveillance methods that can be adopted by other states and companies in meeting surveillance needs; to identify specific radionuclides that may be released in liquid and gaseous waste discharges and the pathways by which they are dispersed in the environment; and to relate the levels of released radionuclides to levels in critical pathways in order to specify the most beneficial sampling and analyses to perform. Author (NSA)

N71-30165# Committee on Interior and Insular Affairs (U.S. Senate).
FUELS AND ENERGY
Washington GPO 1970 262 p refs Hearings on S. 4092 before Comm. on Interior and Insular Affairs, 91st Congr., 2d Sess., 10–11 Sep. 1970
Avail: Subcomm. on Minerals, Mater., and Fuels
Public hearings on September 10–11, 1970 before the Senate Subcommittee on Minerals, Materials, and Fuels regarding a bill to establish a Commission on Fuels and Energy are reported. The purpose of such a commission is to recommend programs and policies to insure the U.S. requirements for low cost energy are met and to reconcile environmental quality requirements with future energy needs. A.C.R.

N71-30522# Royal Swedish Academy of Engineering Sciences, Stockholm.
NATURAL GAS: ENERGY SOURCE AND RAW MATERIAL [NATURGAS: ENERGIBAERARE OCH RAEVARA]
1970 99 p In SWEDISH
(IVA-Medd-167) Avail: NTIS
The results of an analysis of energy sources available in Sweden show that natural gas must be considered as a supplementary raw material source. Cost and environmental problems are investigated taking advantage of experiences already gained in Russia, Europe, and North America. A possible link-up with existing natural gas networks in Russia or Europe and the use of natural gas on an inter-Scandinavian basis is considered. ESRO

N71-31466*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
USE OF AN AIR-ASSIST FUEL NOZZLE TO REDUCE EXHAUST EMISSIONS FROM A GAS TURBINE COMBUSTOR AT SIMULATED IDLE CONDITIONS
Daniel Briehl and Leonidas Papathakos Washington 1971 21 p refs
(NASA-TN-D-6404; E-6247) Avail: NTIS CSCL 21E
Tests were performed at typical engine idle conditions on a single J-57 combustor liner installed in a 30-cm-(12-in.-) diameter pipe to evaluate design modifications for reducing exhaust emissions. Using an air-assist fuel nozzle, the combustion efficiency was increased from 90.3 to 96.5 percent, and the total hydrocarbon and carbon monoxide exhaust emissions were reduced from 26.3 to 3.3 and from 51 to 40 g/kg of fuel burned, respectively. A corresponding increase in nitric oxide emissions from 0.8 to 1.5 g/kg of fuel burned was observed. Calculations performed for a complete landing-takeoff cycle of a typical engine indicated that the use of an air-assist nozzle during idle could decrease the total quantity of hydrocarbon and carbon monoxide emission by 69 and 20 percent, respectively, while nitric oxide would increase by 14 percent. The required secondary nozzle airflow amounts to less than 0.5 percent of the total engine airflow at idle. Author

N71-35178# Committee on Public Works (U. S. Senate).
OIL SLUDGE DUMPING OFF THE FLORIDA COAST
Washington GPO 1971 94 p refs Hearing before Comm. on Public Works, 91st Congr., 2d Sess., 7 Dec. 1970
Avail: Subcomm. on Air and Water Pollution
Statements and testimony presented to the Subcommittee regarding this major oil spill are documented. Included is a reprint of a report prepared by the Council on Environmental Quality on Ocean Dumping, A National Policy. J.G.M.

N71-35181# Committee on Interior and Insular Affairs (U. S. Senate).
NATIONAL FUELS AND ENERGY POLICY
Washington GPO 1971 133 p refs Hearing on S. Res. 45 before Comm. on Interior and Insular Affairs, 92d Congr., 1st Sess., 25 Feb. 1971
Avail: Comm. on Interior and Insular Affairs
Congressional testimony concerning a study of the nation's energy resources and a review of the body of law and policy which influence the energy situation is presented. Examples of problems throughout the energy system which indicate the need for such an investigation are presented. Statements of law makers from various states are included to define the scope of the problem. P N F

N71-35501 National Lending Library for Science and Technology, Boston Spa (England).
PROGNOSIS OF THE WORLD ENERGY SUPPLY BETWEEN NOW AND THE YEAR 2000 WITH REFERENCE TO THE QUANTITY OF ENERGY RAW MATERIALS CONSUMED
Th. R. Seldenrath 12 Mar. 1971 23 p Transl. into ENGLISH from Chem. Weekbl. (Netherlands), v. 66, no. 44, 30 Oct. 1970 p 20-26
(NLL-Trans-1166-(9022.9)) Avail: Natl. Lending Library, Boston Spa, Engl.: 2 NLL photocopy coupons
A statistical assessment is presented of the nuclear energy, solid fuel, petroleum, natural gas, and water power energy resources in the year 2000. The analysis is based on current economic and technical trends in the world energy consumption and not on potential primary energy sources such as solar radiation or heat from the interior of the earth or potential advancements in reactor technology. J.G.M.

N71-35815# Oak Ridge National Lab., Tenn.
Sr 90 HEAT SOURCES
Roberta Shor, (ed.), Robert H. Lafferty, Jr., (ed.), and P. S. Baker, (ed.) May 1971 134 p refs
(Contract W-7405-eng-26)
(ORNL-IIC-36) Avail: NTIS
This includes purification, transportation, preparation of fuel forms, analytical methods, densification, encapsulation, source testing, and examination of used sources. Details of source preparation, encapsulation, and testing are given. Author (NSA)

N71-36393# Bureau of Mines, Washington, D.C.
REVIEW OF BUREAU OF MINES ENERGY PROGRAM, 1970
Bill Linville and John D. Spencer 1971 119 p refs
(BM-IC-8526) Avail: NTIS
A program of research to help U.S. industry meet the energy demands for fuels, electrical power, and chemicals during the 1970's is discussed. Subjects presented are: (1) solid waste utilization and disposal, (2) coal mine safety, (3) coal storage and shipment, (4) electric power generation from coal, (5) chemicals from coal carbonization,(6) fuels and chemicals by synthesis processes, (7) petroleum and natural gas production, and (8) oil shale utilization. Author

N71-36736# Argonne National Lab., Ill.
WORK PLAN FOR CONTINUATION OF THE PROJECT REDUCTION OF ATMOSPHERIC POLLUTION BY THE

APPLICATION OF FLUIDIZED BED COMBUSTION
A. A. Jonke, G. J. Vogel, L. J. Anastasia, and R. L. Jarry Apr. 1971 38 p refs
(Contract W-31-109-eng-38)
(ANL/ES-CEN-1003) Avail: NTIS

A development program is outlined for a continuing study of the lowering and control of the level of pollutants (SO_2, NO, and particulate) in flue gas from the combustion of fossile fuels, using the fluidized-beds to which limestone is added. The major emphasis of the next phase of work will be on combustion at pressures up to 10 atm and regeneration of the sulfated lime under pressure. Fluidized-bed combustors will be operated in the one- and two-stage modes to investigate effects on NOx and sulfur emissions. The program will include laboratory- and bench-scale work aimed at elucidating mechanisms important to sulfur oxide and nitrogen oxide control. Author

N71-37701 National Lending Library for Science and Technology, Boston Spa (England).
THE RATE OF OXIDATION OF PETROLEUM PRODUCTS IN WATER WITHOUT ADDITION OF NITROGEN
A. I. Iz'yurova 22 Sep. 1971 9 p Transl. into ENGLISH from Gig. Sanit. (USSR), no. 7, 1952 p 12-17
(NLL-NSTIC-Trans-2474-(6180.59)) Avail: Natl. Lending Library, Boston Spa, Engl.: 1 NLL photocopy coupon

The bacterial oxidation of petroleum products in water is discussed. In waters not containing nitrogen, phosphorus and potassium (N, P, K), oxidation of petroleum products did not occur. With sufficient quantities of the nutrients mentioned, bacterial oxidation of petroleum products proceeds very rapidly and the surface of the water, with a petroleum film of 2 mm in thickness is completely purified from this layer in 1-2 months. The process of oxidation of petroleum products can also occur without nitrogen, if phosphorus and potassium are present in the water. The nitrogen necessary for the process was apparently fixed from the air by bacteria. The process of the biological purification of water from petroleum products on the surface of the water, upon addition of all nutrients to the water and upon addition only of phosphorus and potassium was investigated. The petroleum product investigated was machine oil. Author

N72-10830# Mitre Corp., McLean, Va.
A SURVEY OF PROPULSION SYSTEMS FOR LOW EMISSION URBAN VEHICLES
W. E. Fraize and R. K. Lay Sep. 1970 116 p refs Sponsored by DOT
(Contract F19628-68-C-0365)
(PB-200144; UMTA-TRD-52-70-2; M70-45) Avail: NTIS CSCL 13F

An overview is presented of low and negligible emission urban vehicle technology. Propulsion systems suitable for low emission urban vehicles are described. The state-of-the-art of low emission systems is surveyed by direct contact with active development efforts in industry; the more promising areas for future development are reviewed. Exhaust emissions for fossil-fueled heat engines are summarized. A computer program was developed to demonstrate the effect of the various route cycle and vehicle parameters on required power and vehicle speed; results are presented for a typical small urban bus. Author (GRA)

N72-11676# Pisa Univ. (Italy). Lab. Prova Combustibili.
LOW EMISSION FUELS AND DEVICES FOR AVIATION ENGINES
G. Nardi *In* AGARD Aircraft Fuels, Lubricants, and Fire Safety Aug. 1971 13 p refs (See N72-11668 02-27)
Avail: NTIS HC $6.00/MF $0.95

Reduction of harmful emissions of turbine engine exhaust system is reviewed. The type of fuel used, combustion chambers, and operating conditions of combustors are also investigated. Author

N72-11677# Lucas Gas Turbine Equipment, Ltd., Burnley (England).
FUEL RELATED PROBLEMS IN AIRCRAFT FUEL SYSTEMS
S. L. Forgham and R. G. Beckett *In* AGARD Aircraft Fuels, Lubricants, and Fire Safety Aug. 1971 14 p refs (See N72-11668 02-27)
Avail: NTIS HC $6.00/MF $0.95

Aircraft fuel problems are discussed, emphasizing problems associated with hydrogen treated fuels. Some of the problems were overcome by fuel system design modification, and other changes are reviewed which were instituted by refinery industries. Research on fuel sealing is also described. J.A.M.

N72-12262*# Aerojet-General Corp., El Monte, Calif. Microwave Div.
A STUDY OF PASSIVE MICROWAVE TECHNIQUES APPLIED TO GEOLOGIC PROBLEMS
A. T. Edgerton *In* NASA. Manned Spacecraft Center 3d Ann. Earth Resources Program Rev., vol. 1 1970 12 p

Avail: NTIS CSCL 08G

Passive microwave techniques were applied to geologic problems, in order to establish the microwave properties of representative rocks and minerals, and to examine the feasibility of using microwave radiometry for geologic mapping problems. A review of microwave pertaining to geology was conducted, coupled with laboratory and field investigations of the microwave emission characteristics of various geologic features. The laboratory studies consisted of dielectric constant measurements of rocks and minerals. A majority of field investigations conducted in the western United States, involved the microwave emission charateristics of rock types, and a portion of the study was concerned with microwave properties of mineralized areas. Experiments were also conducted in the vicinity of a coal seam fire in Colorado and across the San Andreas Fault Zone near the Salton Sea, in Southern California. Author

N72-12311*# Naval Research Lab., Washington, D.C.
RADAR MONITORING OF OIL POLLUTION
N. W. Guinard *In* NASA. Manned Spacecraft Center 3d Ann. Earth Resoureces Program Rev., Vol. 3 1970 1 p (See N72-12295 03-13)
Avail: NTIS HC $6.00/MF $0.95

Radar is currently used for detecting and monitoring oil slicks on the sea surface. The four-frequency radar system is used to acquire synthetic aperature imagery of the sea surface on which the oil slicks appear as a nonreflecting area on the surface surrounded by the usual sea return. The value of this technique was demonstrated, when the four-frequency radar system was used to image the oil spill of tanker which has wrecked. Imagery was acquired on both linear polarization (horizontal, vertical) for frequencies of 428, 1228, and 8910 megahertz. Vertical returns strongly indicated the presence of oil while horizontal returns failed to detect the slicks. Such a result is characteristic of the return from the sea and cannot presently be interpreted as characteristics of oil spills. Because an airborne imaging radar is capable of providing a wide-swath coverage under almost all weather conditions, it offers promise in the development of a pollution-monitoring system that can provide a coastal watch for oil slicks. Author

N72-12329*# Earth Satellite Corp., Washington, D.C.
REMOTE SENSING FOR MINED AREA RECLAMATION: APPLICATION INVENTORY
1 Jun. 1971 40 p ref Sponsored by NASA
(NASA-CR-124608; NASA-Task-160-75-73-04-10; IR-USGS-218) Avail: NTIS CSCL 08G

Applications of aerial remote sensing to coal mined area reclamation are documented, and information concerning available data banks for coal producing areas in the east and midwest is given. A summary of mined area information requirements to which remote sensing methods might contribute is included. Author

N72-12617# Los Alamos Scientific Lab., N.Mex.
Pu-238 SPACE ELECTRIC POWER FUEL DEVELOPMENT PROGRAM Quarterly Status Report, 1 Oct. - 31 Dec. 1970

Jun. 1971 17 p
(Contract W-7405-eng-36)
(LA-4697) Avail: NTIS

Efforts during the report period were devoted mostly to development of PuO2-Mo fuel disks. Development studies were initiated in support of heat sources using (Pu-238)O2/ThO2 fuels. Data used in characterization of PuO2-Mo cermets are included. NSA

N72-14402# Aerojet-General Corp., El Monte, Calif. Microwave Div.
MICROWAVE RADIOMETRIC DETECTION OF OIL SLICKS Final Report, 12 Jun. 1970 - 28 Feb. 1971
D. C. Meeks, D. P. Williams, R. M. Wilcox, and A. T. Edgerton Mar. 1971 103 p refs
(Contract DOT-CG-93228-A; USCG Proj. 714104/A/002)
(AD-728551, AGC-1335-2; FR-2) Avail: NTIS CSCL 13/2

Two years of research have been conducted to determine the feasibility of using microwave radiometry for the detection, identification, and surveillance of oil pollution. Theoretical studies consisted of a review of contemporary theory concerning parameters that influence microwave emission from both unpolluted and oil-covered seas. Laboratory investigations confirm results obtained from earlier studies and established the response characteristics of the 3.2-mm sensor to continuous oil films. Airborne measurements of controlled spills off the Southern California Coast were performed with dual-polarized 3.2- and 8.1-mm sensors oriented with a forward antenna viewing angle 45 deg above nadir. Four sets of oil spills, or missions, were performed to obtain data over a variety of sea-surface conditions. Pollutants used for the tests included No. 2 diesel fuel, 26.1 and 21.6 API gravity crude oils, and 9.7 API gravity fuel oil. Significant microwave brightness temperature oil slick signatures were noted for a wide range of ocean conditions (sea states 1-4) and oil film thickness (thickness + 1 micron and greater). Based on the experimental results a passive microwave imaging system configuration has been recommended for oil pollution surveillance. Author (GRA)

N72-14478# Coast Guard, Washington, D.C. Applied Technology Div.
THE APPLICABILITY OF REMOTE SENSOR TECHNIQUES FOR OIL SLICK DETECTION
Clarence E. Catoe 25 Feb. 1971 29 p refs
(CG Proj. 714104)
(AD-728422; USCG-71404-(A)-009) Avail: NTIS CSCL 13/2

The applicability of remote sensing techniques to the detection of oil films on water is furnished. Short reviews of various imaging techniques and their feasibility as oil film detectors are provided. The results of Coast Guard sponsored research to develop characteristics signatures for sensors operating in the UV to microwave of the electromagnetic spectrum are given. Field test results of existing passive and active sensors obtained from oil spill overflights is presented. Author (GRA)

N72-16196# Centre d'Etude de l'Energie Nucleaire, Mol (Belgium).
LARGE SCALE PRODUCTION OF Ac-227 AND DEVELOPMENT OF AN ISOTOPIC HEAT SOURCE FUELED WITH Ac2O3
L. H. Baetsle, P. Dejonghe, A. C. Demildt, M. J. Brabers (Louvain Univ., Belgium), A. DeTroyer (Union Miniere, Burssels, Belgium), A. Droissart, and M. Poskin (Union Miniere, Brussels, Belgium) May 1971 16 p refs Presented at the 4th Intern. Conf. on the Peaceful Uses of Atomic Energy, Geneva, 6-16 Sep. 1971
(A/Conf-49/P/287; Conf-710901-106) Avail: AEC Depository Libraries

The irradiation devices and hot cell facilities including a radon absorption facility adapted for work with large quantities of Ra-226 and the resulting amounts of Ac-227 and Th-228 were completed and put into operation during the last quarter of 1969. The first irradiation took place in November 1969 and after several months of adaptation and improvement of the installation, routine production has now been started. A production of the order of 20 to 30 g Ac-227 per year is possible in the existing facilities in the near future. A double containment, during irradiation in BR2, is ensured by putting the welded capsules in an aluminum rig (thimble) connected to a suitable instrumented control panel. Three hot cells were fitted out with chemical equipment for precipitation, ion exchange techniques, and handling of oxide powders. Three other hot cells are installed to fabricate and test the heat source. A prototype heat source of 30 Watts to test fuel and capsule behavior and the venting system is now in preparation. Author (NSA)

N72-16934# Massachusetts Inst. of Tech., Cambridge. Fluid Mechanics Lab.
EFFECTIVE STACK HEIGHTS FOR TALL STACKS
Jeffery C. Weil and David P. Hoult Oct. 1971 46 p refs
(F03-AP-41-1105-02)
(FML-Publ-71-14) Avail: NTIS

A simple method is given to predict the effective stack height for a tall stack and the corresponding ground-level concentrations of the effluents emitted from the stack. The height of the convective mixing region of the atmosphere determines when the effluents are carried to the ground in downward moving air currents. A model to determine the scale of the mixing region is presented and verified with vertical temperature profile measurements. Previous theories on buoyant plume rise are used to determine the effective stack height. For a plume rising in a stable atmosphere the levelled-off height of the plume is shown to be the effective stack height. In a neutral atmosphere the effective stack height is given by the height where the plume rise velocity is equal to the vertical velocity scale in the mixing layer. A total of 760 measurements of the axial ground-level concentration of sulfur dioxide downwind of a 244 m stack are empirically correlated. Author

N72-16981# RWE-Aktiegesellschaft, Essen (West Germany).
RESOURCES OF PRIMARY ENERGY
Heinrich Mandel 24 Feb. 1972 27 p refs Presented at 4th Intern. Conf. on The Peaceful Uses of Atomic Energy, Geneva, Switzerland, 6 Sep. 1971
(A/Conf-49/P/359; Conf-710901-123) Avail: AEC Depository Libraries

The fossil fuels should be sufficient for about 460 years, the basic materials for nuclear fission even sufficing for 25,000 years. This consideration, however, leads to false conclusions. It is necessary to take into account the world's population growth as well as the increasing per capita consumption. The result is that the reserves of fossil fuels would be sufficient for some more years only towards the end of the 21st century, whereas nuclear fuels would suffice for about 300 years. This means that, on one hand, the world will be dependent upon nuclear fusion at long sight, but that, on the other hand, sufficient time will be left to develop it. Author (NSA)

N72-17737# Oak Ridge National Lab., Tenn.
ROD : A NUCLEAR AND FUEL CYCLE ANALYSIS CODE FOR CIRCULATING FUEL REACTORS
H. F. Bauman, G. W. Cunningham, III, J. L. Lucius, H. T. Kerr, and C. W. Craven, Jr. Sep. 1971 244 p refs
(Contract W-7405-eng-26)
(ORNL-TM-3359) Avail: NTIS

ROD (reactor optimum design) is a computer code for simultaneously optimizing the core design and performing the fuel-cycle analysis for circulating-fuel reactors. It consists of a multigroup diffusion calculation, including multiple thermal groups with neutron upscatter, in one-dimension or in two-dimensional synthesis, combined with an equilibrium fuel-cycle calculation. Cross sections in the CITATION format are required. The equilibrium calculation is a fuel cycle model, including the effects of processing and of nuclear transmutation and decay. Fuel-cycle costs and fission-product concentrations are calculated, the fission products by an independent calculation from internally stored two-group cross sections. Special features of ROD are an

optimization routine based on the gradient-projection method, a flux-plotting option, and a subprogram for simple time-dependent calculations based on reaction rates from the main program.
Author (NSA)

N72-18760# Bureau of Mines, Pittsburgh, Pa. Energy Research Center.
CLEAN AUTOMOTIVE FUEL: LABORATORY-SCALE OPERATION OF THE SYNTHANE PROCESS
A. J. Forney, W. P. Haynes, J. J. Elliott, and R. F. Kenny Feb. 1972 8 p refs
(TPR-49) Avail: NTIS

A high-Btu gas was made in order to demonstrate the feasibility of using the gas as a nonpolluting fuel for automobiles. The pilot plants were revised to combine the processes of coal gasification, gas purification, and catalytic methanation into one overall system. Tests in test automobiles showed the Synthane gas was less polluting than natural gas.
Author

N72-18761# Bureau of Mines, Bartlesville, Okla. Energy Research Center.
CLEAN AUTOMOTIVE FUEL: ENGINE EMISSIONS USING NATURAL GAS, HYDROGEN-ENRICHED NATURAL GAS, AND GAS MANUFACTURED FROM COAL (SYNTHANE)
D. B. Eccleston and R. D. Fleming Feb. 1972 15 p refs
(TPR-48) Avail: NTIS

Natural gas and mixtures of natural gas and hydrogen were used as fuels in a laboratory engine to determine the relationship of emissions to air-fuel ratio and to establish practical lean limits for air-fuel ratio. Synthetic gas manufactured from coal (Synthane) and natural gas were used as fuels in a vehicle to obtain comparative data on emissions and performance. Results showed that lean limits for air-fuel ratio when using hydrogen-enriched natural gas were extended significantly beyond that of natural gas. Synthane produced exhaust that was significantly less reactive than exhaust from natural gas. With lean air-fuel ratios, the acceleration performance of a vehicle fueled with Synthane was improved over its performance when fueled with natural gas.
Author

N72-19686# Environmental Protection Agency, Research Triangle Park, N.C.
COMPILATION OF AIR POLLUTANT EMISSION FACTORS
Feb. 1972 172 p refs Revised
(AP-42-Rev) Avail: SOD $1.50

Emission data are presented from source tests, material balance studies, engineering estimates, etc., for use by individuals and groups responsible for conducting air pollution emission inventories. The emission factors given cover most of the common emission categories: fuel combustion by stationary and mobile sources; combustion of solid wastes; evaporation of fuels; solvents, and other volatile substances; industrial processes; and miscellaneous sources. When no source test data are available, these factors can be used to estimate the quantities of primary pollutants (particulates, CO, SO2, NOx, and hydrocarbons) being released from a source or source group.
Author

N72-20472# Grand Junction Office (AEC), Colo.
STATISTICAL DATA OF THE URANIUM INDUSTRY
1 Jan. 1971 54 p
(TID-25814) Avail: NTIS

A compilation of historical facts and figures and current status as of Jan. 1, 1971 of the U.S. uranium industry is presented. Information is included on ore and concentrate purchases, uranium resources, distribution of deposits, drilling statistics, land acquisition for U mining and exploration, employment, domestic U3O8 sales and projected requirements, and processing mills.
NSA

N72-20479# Toronto Univ. (Ontario). Inst. for Aerospace Studies.
THE DEVELOPMENT OF AN AIRBORNE REMOTE LASER FLUOROSENSOR FOR USE IN OIL POLLUTION DETECTION AND HYDROLOGIC STUDIES
R. M. Measures and M. Bristow Dec. 1971 36 p refs
Sponsored by Dept. of Energy, Mines, and Resources
(UTIAS-175) Avail: NTIS

The first phase of a development program devoted to the exploitation of laser induced fluorescence for environmental sensing has been completed. A prototype laser fluorosensor has been constructed and used to evaluate, in the laboratory, the feasibility of this concept and to explore the potential range of applications. Special attention has been given to assessing the ability of a laser fluorosensor to map the extent of an oil slick, locate the source of lignin sulphonate pollution and monitor the dispersal of a tracer dye for hydrologic uses. The preliminary results are very encouraging and lead to prediction that a laser fluorosensor could be used for environmental sensing from an aircraft flying at between 1000 and 2000 ft on a 24-hour basis.
Author

N72-20603# Aktiebolaget Atomenergi, Studsvik (Sweden).
URANIUM MARKET
1971 30 p refs In SWEDISH
(NP-19069; AES-8) Avail: AEC Depository Libraries

The demand for uranium for use in nuclear power stations is projected to 1985 for the western world. The resources of uranium in western countries and the prospecting efforts are described. Present and future prices of uranium oxides are surveyed.
NSA

N72-23284 Barringer Research, Ltd., Rexdale (Ontario).
CORRELATION SPECTROMETRY APPLIED TO EARTH RESOURCES
Anthony R. Barringer *In* Princeton Univ. Proc. of the Princeton Univ. Conf. on Aerospace Methods for Revealing and Evaluating Earth's Resources Jun. 1970 37 p
Copyright. Avail: Issuing Activity

Spectrometry from aircraft, balloons, and satellites is discussed for detecting minerals and oils, air pollution, and earth structural features. The emphasis is on gases, and in particular air pollutants: sulfur dioxide, nitrogen dioxide, mercury, and iodine. The association of certain gases with mines and mineral deposits and with marine life is described, and aerial detection of air pollution over cities and industrial areas is also discussed.
N.E.N.

N72-23296 United Nations, New York. Resources and Transport Div.
THE EXPLORATION OF NON-AGRICULTURAL NATURAL RESOURCES IN DEVELOPING COUNTRIES BY THE UNITED NATIONS
Joseph Barnea *In* Princeton Univ. Proc. of the Princeton Univ. Conf. on Aerospace Methods for Revealing and Evaluating Earth's Resources Jun. 1970 6 p refs

Copyright. Avail: Issuing Activity

The work of the Economic and Social Affairs Department of the United Nations in exploring resources of economic significance is outlined. The main thrust is in the execution of projects in developing countries. Activities are reported on exploring for minerals (including copper and uranium), ground water, rivers and river basins, steam fields (geothermal energy), offshore petroleum, and offshore tin.
N.E.N.

N72-23655# Department of Transportation, Washington, D.C. Library Services Div.
AIRCRAFT AND AIR POLLUTION, SELECTED READINGS
Report for 1960 - 1971
Dorothy J. Poehlman Dec. 1971 68 p
(AD-735943; Bibliographic-List-7) Avail: NTIS CSCL 13/2

Presented is a selected, partially annotated listing of papers, reports, and periodical articles, on the subject of environmental pollution caused by aircraft emissions. Noise pollution is not

included. The period covered is from approximately 1960 - Spring 1971. The arrangement is by subject categories with author, corporate source and geographic indexes. Author (GRA)

N72-23806# Shell Development Co., Emeryville, Calif.
HYDROCARBON FUELS FOR ADVANCED SYSTEMS Annual Technical Report No. 2, 1 Sep. 1970 - 31 Aug. 1971
L. E. Faith, G. H. Ackerman, C. K. Heck, H. T. Henderson, A. W. Ritchie, and L. B. Ryland Wright-Patterson AFB, Ohio AFAPL Dec. 1971 270 p refs
(Contract F33615-70-C-1038; AF Proj. 3048)
(AD-737372; S-14120; AFAPL-TR-70-71-Pt-2) Avail: NTIS CSCL 21/2

The general objective was the development of new hydrocarbon fuels and new fuel systems which will meet the cooling and propulsion requirements of advanced air-breathing engines. The preparation of catalysts for both packed bed and catalyst lined reactors and the evaluation of catalyst activity and stability for the dehydrogenation of methylcyclohexane and decalin discussed. Several catalyst lined reactors were tested under realistic heat transfer and reaction conditions. The Beta-Ray Deposit Rater was developed, tested, and used to rate coke deposits on tubes from thermal stability tests. The effects of various stability additives in different fuels were investigated. Viscosities of different hydrocarbons, including shelldyne H and shelldyne - H/hydrocarbon mixtures, were measured. The effects of exposure to elastomers on the properties of shelldyne - H fuel were analyzed. Ignition delay times and combustion rates were measured for decalin and its dehydrogenation products. A bibliography of current articles and patents of interest to this and related programs is included. Author (GRA)

N72-24703# Oak Ridge National Lab., Tenn.
ORNL ISOTOPIC POWER FUELS Quarterly Report, period ending 30 Sep. 1971
Eugene Lamb Dec. 1971 36 p refs
(Contract W-7405-eng-26)
(ORNL-4750) Avail: NTIS

The development of fuel forms with optimum design for use at temperature up to 2,000 C is discussed. The process involves obtaining the characteristics of isotopic power and heat sources for anticipated applications in aerospace, terrestrial, and marine environments. The physical and chemical properties of the compound and source form, such as thermal conductivity, density, gas retention, and melting point must be determined. Compatibility of the fuel form with container materials must be established to ensure adequate containment during the intendec lifetime of the mission. Author

N72-25345*# Techtran Corp., Glen Burnie, Md.
THE EOLE PROGRAM
Washington NASA 28 Feb. 1972 32 p Transl. into ENGLISH from "Le Programme Eole", Centre Natl. d'Etudes Spatiales, Paris, France, 1972 31 p
(Contract NASw-2037)
(NASA-TT-F-14279) Avail: NTIS HC $3.75 CSCL 08C

The Eole program is an experimental program to determine the effectiveness of satellite monitoring of drifting buoys and balloons in the Southern Hemisphere. The results of the program thus far are summarized, and the future need and demand for this type of service in determining the position of ships and in collecting and transmitting data of hydrological, oceanographic, and meteorological interest are considered. Author

N72-25584# Bureau of Mines, Bartlesville, Okla.
A FIELD SURVEY OF EMISSIONS FROM AIRCRAFT TURBINE ENGINES
F. W. Cox, F. W. Penn, and J. O. Chase 1972 32 p refs
(BM-RI-7634) Avail: NTIS HC $3.75

Exhaust emissions were measured from 25 aircraft turbine engines using Jet A fuel. Analytical apparatus, procedures, and results are described. Carbon monoxide, carbon dioxide, nitric oxide, nitrogen dioxide, and aldehydes were measured at engine operating modes representing power levels used in airline operation. Carbon monoxide, hydrocarbon, and aldehyde emissions were highest at idle and lowest at takeoff; oxides of nitrogen were lowest at idle and highest at takeoff. Of the total oxides of nitrogen emitted, nitrogen dioxide constituted from 10 to 100 pct, depending on the exhaust gas temperature. Engines retrofitted with smoke reducing burner cans produced less carbon monoxide, hydrocarbon, and aldehyde emissions, and slightly more oxides of nitrogen than engines with standard burner cans. Author

N72-25955*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
APPLICABILITY OF NASA CONTRACT QUALITY MANAGEMENT AND FAILURE MODE EFFECT ANALYSIS PROCEDURES TO THE USGS OUTER CONTINENTAL SHELF OIL AND GAS LEASE MANAGEMENT PROGRAM
Morris K. Dyer, Dewey G. Little, Earl G. Hoard, Alfred C. Taylor, and Rayford Campbell Washington Jun. 1972 43 p refs
(NASA-TM-X-2567) Avail: NTIS HC $3.00 CSCL 05A

An approach that might be used for determining the applicability of NASA management techniques to benefit almost any type of down-to-earth enterprise is presented. A study was made to determine the following: (1) the practicality of adopting NASA contractual quality management techniques to the U.S. Geological Survey Outer Continental Shelf lease management function; (2) the applicability of failure mode effects analysis to the drilling, production, and delivery systems in use offshore; (3) the impact on industrial offshore operations and onshore management operations required to apply recommended NASA techniques; and (4) the probable changes required in laws or regulations in order to implement recommendations. Several management activities that have been applied to space programs are identified, and their institution for improved management of offshore and onshore oil and gas operations is recommended. Author

N72-25986*# National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.
RELIABILITY TECHNIQUES IN THE PETROLEUM INDUSTRY
Henry L. Williams *In its* Govt.-Ind. System Safety Conf. 28 May 1971 p 259-270
Avail: NTIS HC $16.25 CSCL 13L

Quantitative reliability evaluation methods used in the Apollo Spacecraft Program are translated into petroleum industry requirements with emphasis on offsetting reliability demonstration costs and limited production runs. Described are the qualitative disciplines applicable, the definitions and criteria that accompany the disciplines, and the generic application of these disciplines to the chemical industry. The disciplines are then translated into proposed definitions and criteria for the industry, into a base-line reliability plan that includes these disciplines, and into application notes to aid in adapting the base-line plan to a specific operation. G.G.

N72-26334 Idaho Univ., Moscow.
THIRTY-FIVE MILLIMETER COLOR OBLIQUE AERIAL PHOTOGRAPHY AS A TOOL FOR RECONNAISSANCE EXPLORATION FOR URANIUM MINERALIZATION IN THE TERTIARY BASINS OF WYOMING Ph.D. Thesis
Stanley Cameron Grant 1971 236 p
Avail: Univ. Microfilms Order No. 72-2083

An evaluation of techniques, films, and procedures for 35mm color aerial photography in uranium mineral exploration is presented. The Tertiary rocks of the Clarkson Hill-Rattlesnake Range area, 22 miles southwest of Casper, Wyoming, were studied. The Munsell Color System was selected to identify the color in soils and rocks. Soil and rock samples were analyzed by

qualitative emission spectrography to determine possible controls for color. Interpretation of analyses supports findings of others that colors result from oxides of iron in varying quantities. The geology of the primary area was studied to provide an accurate ground basis for aerial photography and to determine locations favorable for uranium mineralization. Tertiary formations and structure were mapped. Dissert. Abstr.

N72-26528*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
NEUTRON RADIATION CHARACTERISTICS OF PLUTONIUM DIOXIDE FUEL
Mojtaba Taherzadeh 1 Jun. 1972 22 p refs
(Contract NAS7-100)
(NASA-CR-127045; JPL-TR-32-1555) Avail: NTIS HC $3.25 CSCL 18J

The major sources of neutrons from plutonium dioxide nuclear fuel are considered in detail. These sources include spontaneous fission of several of the Pu isotopes, (alpha, n) reactions with low Z impurities in the fuel, and (alpha, n) reactions with O-18. For spontaneous fission neutrons a value of (1.95 + or - 0.07) X 1,000 n/s/g PuO2 is obtained. The neutron yield from (alpha, n) reactions with oxygen is calculated by integrating the reaction rate equation over all alpha-particle energies and all center-of-mass angles. The results indicate a neutron emission rate of (1.14 + or - 0.26) X 10,000 n/s/g PuO2. The neutron yield from (alpha, n) reactions with low Z impurities in the fuel is presented in tabular form for one part per million of each impurity. The total neutron yield due to the combined effects of all the impurities depends upon the fractional weight concentration of each impurity. The total neutron flux emitted from a particular fuel geometry is estimated by adding the neutron yield due to the induced fission to the other neutron sources. Author

N72-29272*# New York State Univ., Albany.
TO EVALUATE ERTS-A DATA FOR USEFULNESS AS GEOLOGICAL SENSOR Progress Report, period ending 31 Jul. 1972
Y. W. Isachsen, Principal Investigator 31 Jul. 1972 2 p
Sponsored by NASA
(E72-10020; NASA-CR-127744) Avail: NTIS HC $3.00 CSCL 08G

There are no author-identified significant results in this report.

N72-29317* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
LEWIS RESEARCH CENTER EARTH RESOURCES PROGRAM
Herman Mark *In its* 4th Ann. Earth Resources Program Rev., Vol. 1 21 Jan. 1972 21 p

CSCL 08L

The Lewis Research Center earth resources program efforts are in the areas of: (1) monitoring and rapid evaluation of water quality; (2) determining ice-type and ice coverage distribution to aid operations in a possible extension of the Great Lakes ice navigation and shipping season; (3) monitoring spread of crop viruses; and (4) extent of damage to strip mined areas as well as success of efforts to rehabilitate such areas for agriculture. Author

N72-29363* Bureau of Mines, Pittsburgh, Pa.
THE REMOTE SENSING OF AIR POLLUTION FROM COAL UTILIZATION c20
Brian M. Harney, Donald H. McCrea, and Albert J. Forney *In* NASA. Manned Spacecraft Center 4th Ann. Earth Resources Program Rev., Vol. 3 21 Jan. 1972 14 p refs Original contains color illustrations

CSCL 04B

An investigation was made to determine the feasibility of applying earth resources data to the detection of air pollution, particularly pollution from coal burning. Efforts were also made to detect any damage caused by such pollution to vegetation growth and tree life. Results show that vegetative vigor even at low ambient concentrations was damaged and that Eastern white pine trees were severely damaged by the pollutants. Author

N72-30123# Bureau of Mines, Morgantown, W.Va.
BUREAU OF MINES ENERGY PROGRAM, 1971
John D. Spencer and Bill Linville 1972 109 p refs
(BM-IC-8551) Avail: NTIS HC $7.50

In 1971 increase emphasis was placed on the production of fluid fuels and chemicals from coal. Advances were achieved in the development of the Synthane and Hydrane gasification processes for producing pipeline gas from coal, and progress was made in research on solid wastes utilization, and on liquid fuels production from coal. Coal mine safety, solid waste disposal and utilization, coal preparation and transport, and fundamental research on coal and related products also continued to be the subject of extensive research. Improved methods for extracting petroleum and natural gas without surface and subsurface pollution are discussed. This research was highlighted by studies of the fracturing systems of reservoir rocks, including subsurface fracture mapping and fracturing techniques to achieve optimum production of oil and gas. Oil recovery by water or gas flooding, by steam injection, on the identification of oil spills, and on means to reduce vehicular exhaust emissions is summarized. Author

N72-31082# Army Foreign Science and Technology Center, Charlottesville, Va.
SERIES OF NO-CONTACT SYNCHRONOUS GENERATORS WITH OUTPUTS UP TO 100 kV FOR WIND DRIVEN ELECTRIC UNITS
L. D. Urusov, V. S. Ryzhkov, L. A. Zilbershtein, and V. K. Volchkov 7 Oct. 1971 12 p refs Transl. into ENGLISH from Elektrotekhnika (USSR), no. 1, 1970 p 56-58
(AD-742641; FSTC-HT-23-1434-71) Avail: NTIS CSCL 10/2

The need for design of a specialized series of no-contact synchronous generators with outputs up to 100 kV for wind-driven electric units and the basic technical characteristics of the series of generators are discussed. Author (GRA)

N72-31353*# Bendix Corp., Ann Arbor, Mich.
ECOLOGICAL EFFECTS OF STRIP MINING IN OHIO Progress Report, period ending 5 Aug. 1972
Phillip E. Chase, Principal Investigator 5 Aug. 1972 3 p
(Contract NAS5-21762)
(E72-10069; NASA-CR-128084; Rept-72-141-922) Avail: NTIS HC $3.00 CSCL 08G

There are no author-identified significant results in this report.

N72-31768# Bureau of Mines, Bartlesville, Okla. Energy Research Center.
EMISSION CHARACTERISTICS OF PROPANE AS AUTOMOTIVE FUEL
J. R. Allsup and R. D. Fleming [1972] 38 p refs
(BM-RI-7672; TN23.U7) Avail: NTIS HC $4.00

Air pollutants in exhaust gas produced from LP-gas (propane) were studied using both laboratory engines and vehicles. The objective was to evaluate engine parameters relating to the advantageous use of propane as a low-pollution fuel. Some comparisons are made between gasoline, natural gas, and propane. Results show that engines can operate over a wider range of A/F with minimum carbon monoxide and hydrocarbon emission when using propane than when using gasoline. Mixture enrichment using propane is unnecessary during cold starts, thereby eliminating the emission penalty during warmup. Carbon monoxide and hydrocarbon emission using propane are unaffected

by ambient temperature. The photochemical reactivity of hydrocarbon emission is considerably lower with propane than with gasoline. Author

N72-32336*# Earth Satellite Corp., Washington, D.C.
STUDY OF APPLICATION OF ERTS-1 IMAGERY TO FRACTURE-RELATED MINE SAFETY HAZARDS IN THE COAL MINING INDUSTRY Progress Report, 1 Jul. - 1 Sep. 1972
Charles Wier, Principal Investigator (Indiana Geol. Surv., Bloomington), Frank J. Wobber, Principal Investigator, Orville R. Russell, and Roger Amato 1 Sep. 1972 3 p Sponsored by NASA
(E72-10064; NASA-CR-128080) Avail: NTIS HC $3.00 CSCL 08G

The author has identified the following significant results. Numerous fractures are identifiable on the 1:120,000 color infrared photography. Some of these fractures are in the proximity of operating open pit mines and should provide opportunities for field checking and confirmation.

N72-32742*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
ECONOMIC STUDY OF FUTURE AIRCRAFT FUELS (1970-2000)
Arthur D. Alexander, III Sep. 1972 30 p refs
(NASA-TM-X-62180) Avail: NTIS HC $3.50 CSCL 21D

Future aircraft fuels are evaluated in terms of fuel resource availability and pricing, processing methods, and economic projections over the period 1970-2000. Liquefied hydrogen, methane and propane are examined as potential turbine engine aircraft fuels relative to current JP fuel. Author

N72-32754*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
AIRCRAFT ENGINE POLLUTION REDUCTION
Richard A. Rudey 1972 10 p refs Presented at EASCON 72, Washington, D. C., 16-17 Oct. 1972
(NASA-TM-X-68129; E-7118) Avail: NTIS HC $3.00 CSCL 21A

The effect of engine operation on the types and levels of the major aircraft engine pollutants is described and the major factors governing the formation of these pollutants during the burning of hydrocarbon fuel are discussed. Methods which are being explored to reduce these pollutants are discussed and their application to several experimental research programs is pointed out. Results showing significant reductions in the levels of carbon monoxide, unburned hydrocarbons, and oxides of nitrogen obtained from experimental combustion research programs are presented and discussed to point out potential application to aircraft engines. Author

N72-33736# Naval Postgraduate School, Monterey, Calif.
THE IDENTIFICATION OF NAVAL FUELS AND NATURAL FLUOROPHORS IN SEA WATER BY FLUORESCENCE SPECTROMETRY M.S. Thesis
Hugh W. Howard, Jr. Mar. 1972 82 p refs
(AD-743703) Avail: NTIS CSCL 21/4

Fluorescence and Excitation spectra of Navy Standard Fuel Oil (NSFO), Navy Distillate Fuel (ND), Diesel Fuel and Navy Aircraft fuels (JP-4 and JP-5) were obtained. Excitation spectra and fluorescence spectra are characteristic and may allow selective identification of these fuels. Quantitative determinations by fluorescence analysis of ND fuel oil extracted from sea water samples, with cyclohexane, showed saturation values of approximately 11 ppm. An all glass, in-situ vacuum filtering water sampler was designed and built for collection of filtered (.45 micron glass) noncontaminated sea water samples for the fluorescence analysis determination of the natural background fluorescence. Author (GRA)

N73-10372*# Indiana Geological Survey, Bloomington.
STUDY OF THE APPLICATION OF ERTS-A IMAGERY TO FRACTURE-RELATED MINE SAFETY HAZARDS IN THE COAL MINING INDUSTRY Progress Report, 1 Sep. - 31 Oct. 1972
Charles E. Wier, Frank J. Wobber, Principal Investigators (Earth Satellite Corp.), Orville R. Russell (Earth Satellite Corp.), and Rojer V. Amato (Earth Satellite Corp.) 8 Nov. 1972 3 p refs
(Contract NAS5-21795)
(E72-10193; NASA-CR-128391; PR-2) Avail: NTIS HC $3.00 CSCL 08K

The author has identified the following significant results. Various data compilation and analysis activities in support of ERTS-1 imagery interpretation are in progress or are completed. These include the compilation of mine accident data, areas of mine roof instability and the analysis of high altitude color infrared photography and low altitude color and color infrared photography which was acquired by NASA in support of the project. The photography reveals that many fracture lineaments are detectable through a varied thickness of glacial till. These data will be compiled on a series of 1:250,000 scale base maps and evaluated for a correlation between fracture zones and mine accidents and rooffalls. Due to high occurrence of cloud cover in the project area and to the delay in imagery shipments, little progress has been made in the analysis of ERTS-1 imagery.

N73-11019*# LTV Aerospace Corp., Hampton, Va. Hampton Technical Center.
A FUEL CONSERVATION STUDY FOR TRANSPORT AIRCRAFT UTILIZING ADVANCED TECHNOLOGY AND HYDROGEN FUEL
W. Berry, R. Calleson, J. Espil, C. Quartero, and E. Swanson 10 Nov. 1972 33 p refs
(Contract NAS1-10900)
(NASA-CR-112204) Avail: NTIS HC $3.75 CSCL 01B

The conservation of fossil fuels in commercial aviation was investigated. Four categories of aircraft were selected for investigation: (1) conventional, medium range, low take-off gross weight; (2) conventional, long range, high take-off gross weights; (3) large take-off gross weight aircraft that might find future applications using both conventional and advanced technology; and (4) advanced technology aircraft of the future powered with liquid hydrogen fuel. It is concluded that the hydrogen fueled aircraft can perform at reduced size and gross weight the same payload/range mission as conventionally fueled aircraft. F.O.S.

N73-12356*# Bendix Corp., Ann Arbor, Mich. Aerospace Systems Div.
ECOLOGICAL EFFECTS OF STRIP MINING IN OHIO Bimonthly Progress Report, 5 Aug. - 5 Oct. 1972
Wayne Pettyjohn, Principal Investigator 5 Oct. 1972 4 p Prepared in cooperation with Ohio State Univ., Columbus
(Contract NAS5-21762)
(E72-10256; NASA-CR-129188; Rept-72-141-1084) Avail: NTIS HC $3.00 CSCL 08M

There are no author-identified significant results in this report.

N73-12358*# Ohio Dept. of Economic and Community Development, Columbus.
RELEVANCE OF ERTS TO THE STATE OF OHIO Progress Report, Oct. - Nov. 1972
David C. Sweet, Principal Investigator Nov. 1972 7 p Prepared for Battelle Columbus Labs. Original contains imagery. Original photography may be purchased from EROS Data Center, 10th and Dakota Avenue, Sioux Falls, S. D. 57198
(Contract NAS5-21782; BCL-72-17/G-1793)
(E72-10259; NASA-CR-129191) Avail: NTIS HC $3.00 CSCL 08I

The author has identified the following significant results. The ability to delineate and inventory strip mined areas using ERTS-1 imagery has been established. This gives Ohio a method to rapidly gain an up-to-date inventory of strip mined lands for state planning purposes, which has not been available previously.

Smoke plume detection and sedimentation patterns in Sandusky Bay have also been determined from initial analysis of ERTS-1 data.

N73-12364*# Tennessee Univ., Knoxville. Dept. of Geography.
REGIONAL LANDSCAPE CHANGE: A CASE FOR ERTS-1
John B. Rehder, Principal Investigator and James R. OMalley 27 Nov. 1972 10 p Proposed for presentation at 69th Ann. Assoc. of Am. Geographers Meetings, Atlanta, 15-18 Apr. 1973 Submitted for publication. Original contains imagery. Original photography may be purchased from the EROS Data Center, 10th and Dakota Avenue, Sioux Falls, S. D. 57198
(Contract NAS5-21726)
(E72-10265; NASA-CR-129227) Avail: NTIS HC $3.00 CSCL 08M

There are no author-identified significant results in this report.

N73-12717# Oak Ridge National Lab., Tenn.
Cm-244: A RADIOISOTOPIC POWER FUEL
R. E. McHenry 1972 17 p refs Presented at 2d Intern. Symp. on Power from Radioisotopes, Madrid, 29 May 1972 Sponsored by AEC
(Conf-720519-1) Avail: NTIS

The alpha-emitting radioisotope curium-244 is being developed by the USAEC as a power source for any of several conversion systems which produce electrical power. Projected costs and availability make this radioisotope especially promising. The cost of curium-244 which is produced in nuclear power reactors is estimated at $60/Watt (thermal) in quantities of 95 kW (thermal) per year by 1980. The efficient and safe use of this isotopic fuel requires that a suitable compound be prepared and fabricated into a suitable form with fully characterized physical and chemical properties. The task elements for accomplishing this program consist of compound preparation, source fabrication, compound characterization, source design, and prototype testing. Techniques developed for accomplishing these tasks and the results achieved to date are reviewed. Author (NSA)

N73-13334*# Bendix Corp., Ann Arbor, Mich. Aerospace Systems Div.
DETERMINE UTILITY OF ERTS-1 TO DETECT AND MONITOR AREA STRIP MINING AND RECLAMATION
Interim Report, May - Oct. 1972
Philip E. Chase, Principal Investigator Nov. 1972 9 p
(Contract NAS5-21762)
(E72-10284; NASA-CR-129273; BSR-3489) Avail: NTIS HC $3.00 CSCL 08I

There are no author-identified significant results in this report. Analysis of the strip mine records and aerial photos in the test site (five counties in southeastern Ohio) indicate rapidly increasing stripping in the past few years. The mines are large enough to be detected and their gross characteristics observed in the ERTS-1 imagery. Progress in adapting the Bendix ground station to handling ERTS-1 computer compatible tapes is described.

N73-13991*# Massachusetts Inst. of Tech., Cambridge. Sloan School of Management.
REWARD AND UNCERTAINTY IN EXPLORATION PROGRAMS
Gordon M. Kaufman and Paul G. Bradley (British Columbia Univ.) [1971] 25 p refs
(Grant NGL-22-009-309)
(NASA-CR-129595) Avail: NTIS HC $3.25 CSCL 05A

A set of variables which are crucial to the economic outcome of petroleum exploration are discussed. These are treated as random variables; the values they assume indicate the number of successes that occur in a drilling program and determine, for a particular discovery, the unit production cost and net economic return if that reservoir is developed. In specifying the joint probability law for those variables, extreme and probably unrealistic assumptions are made. In particular, the different random variables are assumed to be independently distributed. Using postulated probability functions and specified parameters, values are generated for selected random variables, such as reservoir size. From this set of values the economic magnitudes of interest, net return and unit production cost are computed. This constitutes a single trial, and the procedure is repeated many times. The resulting histograms approximate the probability density functions of the variables which describe the economic outcomes of an exploratory drilling program. Author

N73-13992*# Massachusetts Inst. of Tech., Cambridge. Sloan School of Management.
TWO STOCHASTIC MODELS USEFUL IN PETROLEUM EXPLORATION
Gordon M. Kaufman and Paul G. Bradley (British Columbia Univ.) [1972] 19 p refs
(Grant NGL-22-009-309)
(NASA-CR-129611) Avail: NTIS HC $3.00 CSCL 05A

A model of the petroleum exploration process that tests empirically the hypothesis that at an early stage in the exploration of a basin, the process behaves like sampling without replacement is proposed along with a model of the spatial distribution of petroleum reserviors that conforms to observed facts. In developing the model of discovery, the following topics are discussed: probabilitistic proportionality, likelihood function, and maximum likelihood estimation. In addition, the spatial model is described, which is defined as a stochastic process generating values of a sequence or random variables in a way that simulates the frequency distribution of areal extent, the geographic location, and shape of oil deposits F.O.S.

N73-14315*# Eason Oil Co., Oklahoma City, Okla.
AN EVALUATION OF THE SUITABILITY OF ERTS DATA FOR THE PURPOSES OF PETROLEUM EXPLORATION
Interim Report, Jun. - Nov. 1972
Robert Collins, Principal Investigator Dec. 1972 8 p
(Contract NAS5-21735)
(E72-10327; NASA-CR-129585) Avail: NTIS HC $3.00 CSCL 08G

There are no author-identified significant results in this report.

N73-14343*# Tennessee Univ., Knoxville. Dept. of Geography.
GEOGRAPHIC APPLICATIONS OF ERTS-A IMAGERY TO RURAL LANDSCAPE CHANGE Progress Report
John B. Rehder, Principal Investigator Dec. 1972 34 p refs Original contains color imagery. Original photography may be purchased from the EROS Data Center, 10th and Dakota Avenue, Sioux Falls, S. D. 57198
(Contract NAS5-21726)
(E72-10355; NASA-CR-129668) Avail: NTIS HC $3.75 CSCL 08F

There are no author-identified significant results in this report. The study area, centered on Knoxville, Tennessee, encompasses nearly 20,000 square miles. The Knoxville Test Site, an 11 x 21 mile area over the city of Knoxville and the western portion of Knox County, has been chosen for the analysis of landscape change detection associated with urban growth. The second area, the Cumberland Plateau Test Site, exhibits landscape change through forest alterations and landform disturbances associated with strip mining in the area and was so chosen for its sharp contrasts in physical and human phenomena as well as its change dynamics. Accomplishments since reception of ERTS-1 imagery include: (1) basic cataloging and classifying of the data into a filling system; (2) a densitometer analysis; (3) first look analysis; and (4) preparation of results from the project. Examples of all four bands of the MSS have been received and analyses reveal distinctive positive and negative reactions. Band 5 has been found to be best for landscape analysis of contrasts between urban and rural landscapes, and band 7 for topographic features and water surfaces. Preliminary results are summarized. A.L.

N73-14400# Woods Hole Oceanographic Institution, Mass.
EASTERN ATLANTIC CONTINENTAL MARGIN PROGRAM OF THE INTERNATIONAL DECADE OF OCEAN EXPLORA-

TION (GX-28193), SOME RESULTS OF 1972 CRUISE OF R/V ATLANTIS 2
K. O. Emery Jul. 1972 18 p refs
(Grant NSF GX-28193)
(PB-211393; WHOI-Ref-72-54) Avail: NTIS HC $3.00 CSCL 08G

A geophysical cruise to the southeastern Atlantic mapped a large ancient delta of the Orange River and a diapiric field off Angola. Both features were initiated during early stages of the separation between Africa and South America, and both may have future economic oil potential. Author (GRA)

N73-15309*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
TABLES OF CRITICAL-FLOW FUNCTIONS AND THERMODYNAMIC PROPERTIES FOR METHANE AND COMPUTATIONAL PROCEDURES FOR BOTH METHANE AND NATURAL GAS
Robert C. Johnson Washington 1972 73 p
(NASA-SP-3074) Avail: NTIS HC $3.00 CSCL 20D

Procedures for calculating the mass flow rate of methane and natural gas through nozzles are given, along with the FORTRAN 4 subroutines used to make these calculations. Three sets of independent variables are permitted in these routines. In addition to the plenum pressure and temperature, the third independent variable is either nozzle exit pressure, Mach number, or temperature. A critical-flow factor that becomes a convenient means for determining the mass flow rate of methane through critical-flow nozzles is tabulated. Other tables are included for nozzle throat velocity and critical pressure, density, and temperature ratios, along with some thermodynamic properties of methane, including compressibility factor, enthalpy, entropy, specific heat, specific-heat ratio, and speed of sound. These tabulations cover a temperature range from 120 to 600 K and pressures to 3 million N/sq m. Author

N73-15340*# Texas Instruments, Inc., Dallas.
EVALUATION OF COMMERCIAL UTILITY OF ERTS-A IMAGERY IN STRUCTURAL RECONNAISSANCE FOR MINERALS AND PETROLEUM Progress Report, 1 Nov. - 31 Dec. 1972
Donald F. Saunders, Principal Investigator 8 Jan. 1973 4 p
(Contract NAS5-21796)
(E73-10004; NASA-CR-129928) Avail: NTIS HC $3.00 CSCL 08G

The author has identified the following significant results. Initial analytical results in Area 3 have been very encouraging. Not only have new major lineaments been detected but many of the intersections of those lineaments correlate with the general location of known mineral deposits while others appear to outline petroleum-bearing basins and uplifts. If later analyses confirm these results the economic impact of ERTS type imagery could be very significant in worldwide mineral and petroleum reconnaissance.

N73-15365*# State of Ohio Dept. of Development, Columbus.
RELEVANCE OF ERTS-1 TO THE STATE OF OHIO Semiannual Progress Report, Jul. - Dec. 1972
David C. Sweet, Principal Investigator, T. L. Wells, and G. E. Wukelic 15 Jan. 1973 41 p Prepared for Battelle Columbus Labs. Original contains imagery. Original photography may be purchased from the EROS Data Center, 10th and Dakota Avenue, Sioux Falls, S. D. 57198
(Contracts NAS5-21782; BCL-72-17/G-1793)
(E73-10032; NASA-CR-129985; SAPR-1) Avail: NTIS HC $4.25 CSCL 08F

The author has identified the following significant results. To date, only one significant result has been reported for the Ohio ERTS program. This result relates to the proven usefulness of ERTS-1 imagery for mapping and inventorying strip-mined areas in southeastern Ohio. ERTS provides a tool for rapidly and economically acquiring an up-to-date inventory of strip-mined lands for state planning purposes which was not previously possible.

N73-15454# Informatics, Inc., Rockville, Md.
RECENT SOVIET INVESTIGATIONS IN GEOTHERMY
Eleanor M. Rowell and Stuart G. Hibben May 1972 91 p refs
(Contract F44620-72-C-0053; ARPA Order 1622)
(AD-750128; AFOSR-72-1959TR; Rept-1) Avail: NTIS CSCL 08/7

The report presents the results obtained in an attempt to provide information on recent Soviet research on geothermy. Emphasis is on the identification and description of high-intensity heat flow areas in the USSR that have or might become potential sites for geothermal power or space heating developments. In general, the information provided consists of background data (geographical, geological and chemical) covering recently investigated areas. Author (GRA)

N73-16771*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
COMPARISON OF COMBUSTION CHARACTERISTICS OF ASTM A-1, PROPANE, AND NATURAL-GAS FUELS IN AN ANNULAR TURBOJET COMBUSTOR
Jerrold D. Wear and Robert E. Jones Washington Jan. 1973 23 p refs
(NASA-TN-D-7135; E-7078) Avail: NTIS HC $3.00 CSCL 21D

The performance of an annular turbojet combustor using natural-gas fuel is compared with that obtained using ASTM A-1 and propane fuels. Propane gas was used to simulate operation with vaporized kerosene fuels. The results obtained at severe operating conditions and altitude relight conditions show that natural gas is inferior to both ASTM A-1 and propane fuels. Combustion efficiencies were significantly lower and combustor pressures for relight were higher with natural-gas fuel than with the other fuels. The inferior performance of natural gas is shown to be caused by the chemical stability of the methane molecule. Author

N73-16948# Delaware Bay Oil Transport Committee, Dover.
ENERGY, OIL, AND THE STATE OF DELAWARE. A PROPOSAL FOR SAFEGUARDING THE DELAWARE ESTUARY AND COASTLINE BY SAFER TRANSPORT OF OIL
15 Jan. 1973 61 p refs
Avail: NTIS HC $5.25

The pollution hazards of petroleum industries and shipping in the Delaware Bay are considered. Petroleum refineries on the Delaware River, Delaware River traffic, lightering operations in the lower bay, cleanup responsibility of spilled oil, oil imports, and world crude oil transportation are discussed along with alternative petroleum transport systems. Recommendations for the increased protection from spills are included. F.O.S.

N73-17719# Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes Nucleaires.
PEACEFUL APPLICATIONS OF NUCLEAR EXPLOSIONS: MINES, CHEMISTRY, AND GAS AND OIL EXTRACTION
Micheline C. Berton Aug. 1972 285 p refs Partly in ENGLISH; mostly in FRENCH
(CEA-Bib-129-Add-1) Avail: AEC Depository Libraries

This bibliography is complementary to the bibliography CEA-BIB-129 written in 1968. It comprises 788 references covering principally the following domains: Nuclear Science Abstracts; Government Research Abstracts; Scientific and Technical Aerospace Reports; Bulletin Signaletique of the C.N.R.S.; Index de la Litterature Nucleaire Francaise; and Reports and books of the Central Library of Saclay. The documents are presented in a number of chapters indicated in a subject index table. Several indexes appear at the end of the bibliography: authors index, index of reports, index of review articles, index of congresses, index of books, and a patents index. NSA

N73-17916*# Pratt and Whitney Aircraft, West Palm Beach, Fla. Research and Development Center.
EFFECT OF FUEL ZONING AND FUEL NOZZLE DESIGN

ON POLLUTION EMISSIONS AT GROUND IDLE CONDITIONS FOR A DOUBLE-ANNULAR RAM-INDUCTION COMBUSTOR Final Report
T. R. Clements Feb. 1973 61 p refs
(Contract NAS3-11159)
(NASA-CR-121094; FR-5295) Avail: NTIS HC $5.25 CSCL 21B

An exhaust emission survey was conducted on a double-annular ram induction combustor at simulated ground idle conditions. The combustor was designed for a large augmented turbofan engine capable of sustained flight speeds up to Mach 3.0. The emission levels of total hydrocarbon (THC), carbon monoxide, carbon dioxide, and nitric oxide were measured. The effects of fuel zoning, fuel nozzle design, and operating conditions (inlet temperature and reference Mach number) on the level of these emissions were determined. At an overall combustor fuel/air ratio of 0.007, fuel zoning reduced THC emissions by a factor of 5 to 1. The reduction in THC emissions is attributed to the increase in local fuel/air ratio provided by the fuel zoning. An alternative method of increasing fuel/air ratio would be to operate with larger-than-normal compressor overboard bleed; however, analysis on this method indicated an increase in idle fuel consumption of 20 percent. The use of air-atomizing nozzles reduced the THC emissions by 2 to 1. Author

N73-18321*# Indiana Geological Survey, Bloomington. Coal Section.
APPLICATION OF ERTS-A IMAGERY TO FRACTURE RELATED MINE SAFETY HAZARDS IN THE COAL MINING INDUSTRY Progress Report, Jul. 1972 - Jan. 1973
Charles E. Wier and Frank J. Wobber, Principal Investigators Jan. 1973 52 p refs Original contains imagery. Original photography may be purchased from the EROS Data Center, 10th and Dakota Avenue, Sioux Falls, S. D. 57198
(Contract NAS5-21795)
(E73-10096; NASA-CR-130345) Avail: NTIS HC $4.75 CSCL 08I

The author has identified the following significant results. The most important result to date is the demonstration of the special value of repetitive ERTS-1 multiband coverage for detecting previously unknown fracture lineaments despite the presence of a deep glacial overburden. The Illinois Basin is largely covered with glacial drift and few rock outcrops are present. A contribution to the geological understanding of Illinois and Indiana has been made. Analysis of ERTS-1 imagery has provided useful information to the State of Indiana concerning the surface mined lands. The contrast between healthy vegetation and bare ground as imaged by Band 7 is sharp and substantial detail can be obtained concerning the extent of disturbed lands, associated water bodies, large haul roads, and extent of mined lands revegetation. Preliminary results of analysis suggest a reasonable correlation between image-detected fractures and mine roof fall accidents for a few areas investigated. ERTS-1 applications to surface mining operations appear probable, but further investigations are required. The likelihood of applying ERTS-1 derived fracture data to improve coal mine safety in the entire Illinois Basin is suggested from studies conducted in Indiana.

N73-18353*# Geological Survey, Menlo Park, Calif.
IDENTIFICATION OF GEOSTRUCTURES OF CONTINENTAL CRUST PARTICULARLY AS THEY RELATE TO MINERAL RESOURCE EVALUATION Progress Report, 1 Jul. - 31 Dec. 1972
George Gryc, Principal Investigator and Ernest H. Lathram 31 Dec. 1972 5 p
(NASA Order S-70243-AG-1)
(E73-10321; NASA-CR-130739) Avail: NTIS HC $3.00 CSCL 08G

The author has identified the following significant results. Lakes in the Arctic Coastal Plain of Alaska are dominantly elongate, with their long axes parallel and trending about N 9 W. On ERTS-1 imagery, an additional strong east-trending regional lineation, not previously recognized on aerial photographs or in field study, was noted. In addition, the alignment of many small lakes forms a large and a small ellipse superimposed on the regional lineation. Fischer and Lathram find that the trend of this lineation is parallel to the trend of deflections in contours of the magnetic and gravity fields in the area, and parallel to westerly deflections in the northwest ends of northwest-trending folds mapped to the south. These data suggest that heretofore unsuspected structures may be concealed beneath Quaternary mantling sediments in the area of the image. The strata in these folds would be younger than those tapped by the oil wells of the Umiat field to the south, and favorable sandstone facies may occur in the area. The significance of these observations to oil exploration in northern Alaska needs to be evaluated further.

N73-18354*# Eason Oil Co., Oklahoma City, Okla.
AN EVALUATION OF THE SUITABILITY OF ERTS DATA FOR THE PURPOSES OF PETROLEUM EXPLORATION Progress Report, Dec. 1972 - Jan. 1973
Robert J. Collins, Jr., Principal Investigator 7 Mar. 1973 4 p
(Contract NAS5-21735)
(E73-10322; NASA-CR-130740) Avail: NTIS HC $3.00 CSCL 08G

There are no author-identified significant results in this report.

N73-18960*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
PERFORMANCE GAINS BY USING HEATED NATURAL-GAS FUEL IN AN ANNULAR TURBOJET COMBUSTOR
Nicholas R. Marchionna Washington Mar. 1973 20 p refs
(NASA-TM-X-2742; E-7236) Avail: NTIS HC $3.00 CSCL 21E

A full-scale annular turbojet combustor was tested with natural gas fuel heated from ambient temperature to 800 K (980 F). In all tests, heating the fuel improved combustion efficiency. Two sets of gaseous fuel nozzles were tested. Combustion instabilities occurred with one set of nozzles at two conditions: one where the efficiency approached 100 percent with the heated fuel; the other where the efficiency was very poor with the unheated fuel. The second set of nozzles exhibited no combustion instability. Altitude relight tests with the second set showed that relight was improved and was achievable at essentially the same condition as blowout when the fuel temperature was 800 K (980 F). Author

N73-19366*# Earth Satellite Corp., Washington, D.C.
STUDY OF APPLICATION OF ERTS-A IMAGERY TO FRACTURE RELATED MINE SAFETY HAZARDS IN THE COAL MINING INDUSTRY Progress Report, 1 Jan. - 1 Mar. 1973
Charles E. Wier, Frank J. Wobber, Principal Investigators, Orville R. Russell, and Roger Amato 16 Mar. 1973 10 p Prepared for Ind. Geol. Surv.
(Contract NAS5-21795)
(E73-10371; NASA-CR-131012) Avail: NTIS HC $3.00 CSCL 08I

The author has identified the following significant results. The utility of ERTS-1/high altitude aircraft imagery to detect underground mine hazards is strongly suggested. A 1:250,000 scale mined lands map of the Vincennes Quadrangle, Indiana has been prepared. This map is a prototype for a national mined lands inventory and will be distributed to State and Federal offices.

N73-20376*# Texas Instruments, Inc., Dallas.
ERTS-1 IMAGERY USE IN RECONNAISSANCE PROSPECTING: EVALUATION OF COMMERCIAL UTILITY OF ERTS-1 IMAGERY IN STRUCTURAL RECONNAISSANCE FOR MINERALS AND PETROLEUM Interim Report, 29 Aug. 1972 - 28 Feb. 1973
Donald F. Saunders, Principal Investigator, G. L. Thomas, and F. E. Kinsman Mar. 1973 32 p refs Original contains imagery. Original photography may be purchased from the EROS Data Center, 10th and Dakota Avenue, Sioux Falls, S. D. 57198
(Contract NAS5-21796)
(E73-10414; NASA-CR-131150) Avail: NTIS HC $3.75 CSCL 08G

The author has identified the following significant results. Five areas in North America (North Slope - Alaska, Superior Province - Canada, Williston Basin - Montana, Colorado, and New Mexico - West Texas) are being studied for discernibility of geological evidence on ERTS-1 imagery. Evidence mapped is compared with known mineral/hydrocarbon accumulations to determine the value of the imagery in commercial exploration programs. Evaluation has proceeded in the New Mexico - Texas area, and to date, results have been better than expected. Clearly discernible structural lineaments in this area are evident on the photographs. Comparison of this evidence with known major mining localities in New Mexico indicates a clear pattern of coincidence between the lineaments and mining localities. In West Texas, lineament and geomorphological evidence obtainable from the photographs define the petroleum-productive Central Basin Platform. Based on evaluation of results in the New Mexico - West Texas area and on cursory results in the other four areas of North America, it is concluded that ERTS-1 imagery will be extremely valuable in defining the regional and local structure in any commercial exploration program.

N73-20391*# Bendix Corp., Ann Arbor, Mich.
ECOLOGICAL EFFECTS OF STRIP MINING IN OHIO Bimonthly Progress Report, 1 Jan. - 1 Mar. 1973
Phillip E. Chase, Principal Investigator 1 Mar. 1973 4 p
(Contract NAS5-21762)
(E73-10430; NASA-CR-131220) Avail: NTIS HC $3.00 CSCL 08I

The author has identified the following significant results. ERTS-1 imagery has identified when reclamation has proved successful, when little lateral extension has occurred in the strip mine, when water has filled an impoundment (4 - 5 acres), and detected narrow contour mines. It has been proven that the CCT contains more information than the imagery received from NASA. A stream is visible in the band 7 digital printout that is not visible in the imagery. Also narrow bodies of water between the high wall and spoils bank and small impoundments (2 - 3 acres) are observed in the digital printout and not in the imagery. Disruption maps (water and bare earth within the mined area) can be made by statistically processing the CCT (decision imagery) or mapping the digital printout with a Bendix digitizer. Reclamation maps will be produced in the near future through decision imagery. There seems little doubt that the mapping of present stripping and the monitoring of the strip mine cycle for changes are practical. Disruption mapping is now an operational capability.

N73-20404*# Eason Oil Co., Oklahoma City, Okla.
AN EVALUATION OF THE SUITABILITY OF ERTS DATA FOR THE PURPOSES OF PETROLEUM EXPLORATION Progress Report, Feb. - Mar. 1973
Robert J. Collins, Principal Investigator 9 Apr. 1973 2 p
(Contract NAS5-21735)
(E73-10444; NASA-CR-131239) Avail: NTIS HC $3.00 CSCL 08G

There are no author-identified significant results in this report.

N73-20413*# Bendix Corp., Ann Arbor, Mich. Aerospace Systems Div.
PRELIMINARY EVALUATION OF THE 15 OCTOBER 1972 ERTS-1 IMAGERY OF EAST CENTRAL OHIO (SCENE 1034-15415)
Wayne A. Pettyjohn, Principal Investigator (Ohio State Univ.) Apr. 1973 19 p refs Original contains imagery. Original photography may be purchased from the EROS Data Center, 10th and Dakota Avenue, Sioux Falls, S. D. 57198
(Contract NAS5-21762)
(E73-10454; NASA-CR-131254; BSR-3661) Avail: NTIS HC $3.00 CSCL 08F

The author has identified the following significant results. Results of a general, physical interpretation of ERTS-1 imagery of east central Ohio are presented. Special emphasis is placed upon geologic features, such as linear features and hydrologic features. Man-made features are included as a matter of interest and image location. The interpretation is compared to available maps of the area and from this an assessment that ERTS-1 is potentially useful for updating and producing geological maps.

N73-20815# Naval Air Engineering Center, Philadelphia, Pa. Ground Support Equipment Dept.
GROUND SUPPORT EQUIPMENT: LOW POLLUTANT FUELS Final Report, Sep. 1971 - Aug. 1972
Thomas Dale Weikel Sep. 1972 33 p refs
(AD-755151; NAEC-GSED-59) Avail: NTIS CSCL 21/4

Alternate fuels, with an emphasis on liquefied natural gas are briefly reviewed for feasibility of use in aircraft ground support equipment to reduce air pollution. Electricity, steam, and Wankel engines were also investigated. It was concluded that the most practical system is the use of liquefied petroleum gas and catalytic converters on present gasoline engine support equipment. Author (GRA)

N73-20819# Battelle Columbus Labs., Ohio.
A BRIEF OVERVIEW OF THE ENERGY REQUIREMENTS OF THE DEPARTMENT OF DEFENSE Final Report
R. W. Sullivan, F. A. Creswick, D. E. Erb, M. S. Farkas, and D. D. Moore Aug. 1972 137 p refs Sponsored in part by ARPA, Arlington, Va.
(Contract DAAH01-72-C-0982)
(AD-754824) Avail: NTIS CSCL 21/4

The report documents the results of a brief program to review the magnitude and nature of the energy requirements of the Department of Defense (DoD) and to identify research and development activities or other actions which should be undertaken by the DoD in order to minimize or ameliorate its energy-related problems. Some of the topics include the following: Energy resources (coal, oil, natural gas, uranium, fusion energy, hydrogen energy); Energy consumption and projections for future requirements; Energy problems; and Specific recommendations (Develop domestic sources of substitute liquid petroleum fuel from oil shale and coal, improve the efficiency of piston and turbine engines, develop strategies for military use of hydrogen as an alternate energy source). GRA

N73-21238*# Linguistic Systems, Inc., Cambridge, Mass.
PROBLEMS CONCERNING AUTOMATIC CONNECTION OF AN AEROGENERATOR TO A NETWORK
F. Delafond Washington NASA Apr. 1973 14 p ref Transl. into ENGLISH from the Algerian Report (French Language)
(Contract NASw-2482)
(NASA-TT-F-14873) Avail: NTIS HC $3.00 CSCL 09C

Modifications were made to the 100 kW Andreau-Enfield experimental aerogenerator, supplying a three-phase network, with the results that: (1) connection to the network was automated and rendered almost instantaneous; (2) propeller starting and stopping were automated; and (3) the amplitude of pumping in high wind was reduced by altering the change-of-pitch speed of the propeller. The machine is functioning problems of power oscillations with wind gusts are still being worked on. It is believed that the aerogenerator is suitable for supplying a large network; for small networks three or more smaller machines would have to work in connection to even out power variations. Author

N73-21253*# Kanner (Leo) Associates, Redwood City, Calif.
PRINCIPLES OF STEEL CONSTRUCTION ENGINEERING IN THE BUILDING AND OPERATION OF WIND DRIVEN POWER PLANTS
Helmut Voigt Washington NASA Apr. 1973 13 p ref Transl. into ENGLISH from Der Stahlbau (West Germany), v. 23, no. 8, Aug. 1954 p 184-188
(Contract NASw-2481)
(NASA-TT-F-14872) Avail: NTIS HC $3.00 CSCL 13B

The factors which affect the designing of wind-driven power plants are discussed, including purpose and nominal output, wind velocity as a function of height, wind forces as a function of height, and the torques to be expected. Design features of the

ZYKLON wind-driven power plants are summarized, and sample calculations are made, based on the ZYKLON-D 30 project. The optimal shaft height for a 30-m wind turbine is found to be 50 m above ground, with a yearly output of 2,125,000 kWh at a cost of 2.68 German pfennigs per kWh. Author

N73-21316*# Stanford Univ., Calif. School of Earth Sciences.
STRUCTURAL AND LITHOLOGIC STUDY OF NORTHERN COAST RANGES AND SACRAMENTO VALLEY, CALIFORNIA Progress Report
Ernest I. Rich, Principal Investigator 1 Mar. 1973 4 p ERTS
(Contract NAS5-21775)
(E73-10478; NASA-CR-131283) Avail: NTIS HC $3.00 CSCL 08F

The author has identified the following significant results. Analysis of ERTS-1 imagery of the Northern California Coast Ranges has disclosed a potential relation between a heretofore unrecognized fracture system and known deposits of mercury and geothermally active areas in the Coast Range and between oil and gas fields in the Sacramento Valley. Three potentially important systems of linear elements within the Coast Ranges, detected on ERTS-1 imagery, may represent fault systems or zones of shearing because topographic offset and stratigraph disruption can be seen along one or two of the lineations. One of the systems in subparallel to the San Andreas fault and is confined to the Pacific Coastal Belt. Another set is confined to the central core of the Coast Ranges. The third set of linear features (Valley System) has not heretofore been recognized. Some of the known mercury deposits and geothermally active areas near Clear Lake, in the Coast Ranges, are along the Valley System or at the intersection of the Central and Valley Systems. The plotted locations of some of the oil and gas fields in the Sacramento Valley are associated with the Valley and/or Central Systems. If these relations prove reliable, the ERTS-1 imagery may prove to be an extremely useful exploration tool. A.L.

N73-22284*# Alabama Univ., University.
INVESTIGATIONS USING DATA IN ALABAMA Bimonthly Progress Report, 7 Dec. 1972 - 9 Feb. 1973
Harold R. Henry, Principal Investigator 9 Feb. 1973 31 p ERTS
(Contract NAS5-21876)
(E73-10509; NASA-CR-131469; BMPR-2) Avail: NTIS HC $3.75 CSCL 08F

There are no author-identified significant results in this report.

N73-22384 George Washington Univ., Washington, D.C.
THE FEASIBILITY OF DETECTING SUBSURFACE COAL FIRES IN WYOMING AND MONTANA FROM THE GROUND, ON AERIAL PHOTOGRAPHY AND ON SATELLITE IMAGERY Ph.D. Thesis
George A. Rabchevsky 1972 423 p
Avail: Univ. Microfilms Order No. 72-25062

An investigation was made to determine the usefulness of ground, aircraft and satellite remote sensing methods for the detection of surface and subsurface coal fires burning in north central Wyoming and southern Montana. Field studies were conducted during the spring, summer and fall seasons and used as back-up information for the analysis of available satellite imagery and aerial multispectral photography, provided by the U.S. Bureau of Mines. Ground observations were the most effective and reliable method for the detection of coal fires. Usefulness of the available aerial fall-season multispectral photography was marginal and the examination of the existing satellite imagery, applicable for the detection of coal fires on the ground, was the least productive. Suggestions and recommendations are presented for future more effective photographic aircraft missions and potential satellite programs. Finally, the various existing methods for the detection of coal fires are summarized in a tabular form and their effectiveness compared. Dissert. Abstr.

N73-23011*# Scientific Translation Service, Santa Barbara, Calif.
UTILIZATION OF WIND POWER BY MEANS OF ELEVATED WIND POWER PLANTS
F. Kelinhenz Washington NASA May 1973 30 p refs Transl. into ENGLISH from Technik (East Berlin), v. 2, no. 12, Dec. 1947 p 517-523
(NASA-TT-F-14903) Avail: NTIS HC $3.50 CSCL 13B

Exploitation of wind power by power plants at high altitudes is considered. A design of a wind power plant is proposed and its efficiency and economy in the framework of present conditions in Germany is demonstrated. Although costs are higher than for a coal fired steam plant, they compare favorably with hydroelectric power plants and the saving of coal is a great advantage. The erection of an experimental plant is recommended. Author

N73-23414*# Texas Instruments, Inc., Dallas.
EVALUATION OF COMMERCIAL UTILITY OF ERTS-A IMAGERY IN STRUCTURAL RECONNAISSANCE FOR MINERALS AND PETROLEUM Progress Report, 1 Mar. - 30 Apr. 1973
Donald F. Saunders, Principal Investigator 8 May 1973 4 p ERTS
(Contract NAS5-21796)
(E73-10523; NASA-CR-131490) Avail: NTIS HC $3.00 CSCL 08G

The author has identified the following significant results. The only area that has been analyzed to date is Area 3 where results have already been reported. However, work progressing in Area 1 and 2 seem to indicate a good correlation between lineament zones previously reported, mineralized areas and lineaments currently being picked from ERTS-1 imagery. There also appear to be many lineaments on ERTS-1 imagery in these areas which have not been reported in any other literature.

N73-24268*# Scientific Translation Service, Santa Barbara, Calif.
THE FIRST AERODYNAMIC THREE-PHASE ELECTRIC POWER PLANT IN BALAKLAWA
W. R. Sectorov Washington NASA Jun. 1973 13 p Transl. into ENGLISH from L'Elettrotecnica (Italy), v. 21, no. 23-24, Aug. 1934 p 538-542
(Contract NASw-2483)
(NASA-TT-F-14933) Avail: NTIS HC $3.00 CSCL 10B

The assembly and functional characteristics of an experimental 100 kW power plant built in Crimea are described. The operating data obtained during the first two years of operation are reported. Author

N73-24432# Bureau of Mines, Denver, Colo.
SATELLITE MONITORING OF OPEN PIT MINING OPERATIONS
William C. Henkes 1971 32 p
(BM-IC-8530) Avail: SOD $0.35

The relationships between areal extent, development, volume of waste dumps, and the pits of open pit mining operations as observed on the ground and on photographs taken from satellites are investigated. The ultimate goal is the establishment of criteria to evaluate repetitive space imagery in quantifiable terms. These criteria would aid the Bureau of Mines in discharging its responsibilities in the fields of solid waste disposal, reclamation of mine workings, and mineral resources inventory. The study serves as a basis for additional experiments using remote sensing techniques in the minerals industry. Author

N73-25338*# Bendix Corp., Ann Arbor, Mich.
DETERMINE UTILITY OF ERTS-1 TO DETECT AND MONITOR AREA STRIP MINING AND RECLAMATION Interim Report, Nov. 1972 - Apr. 1973
Phillip E. Chase, Principal Investigator and Larry Reed May 1973 48 p refs Original contains color imagery. Original photography may be purchased from the EROS Data Center, 10th and Dakota Avenue, Sioux Falls, S. D. 57198 ERTS
(Contract NAS5-21762)
(E73-10641; NASA-CR-132100) Avail: NTIS $4.50 CSCL 08I

There are no author-identified significant results in this report.

N73-25342*# Eason Oil Co., Oklahoma City, Okla.
AN EVALUATION OF THE SUITABILITY OF ERTS DATA FOR THE PURPOSES OF PETROLEUM EXPLORATION Interim Report, Dec. 1972 - May 1973
Robert J. Collins, Principal Investigator, F. P. McCown, L. P. Stonis, and Gerald Petzel Jun. 1973 18 p ERTS
(Contract NAS5-21735)
(E73-10646; NASA-CR-132980) Avail: NTIS HC $3.00 CSCL 08G

The author has identified the following significant results. ERTS-1 imagery seems to be good to excellent for reconnaissance level investigations of large sedimentary basins such as the Anadarko Basin. Many lithologic boundaries, and geomorphic features, and linear features inferred to be indicative of geologic structure are visible in the imagery. This imagery in conjunction with high altitude photography seems to be useful as a tool for intermediate level geologic exploration. Several types of crudely circular anomalous features, such as geomorphic/structural anomalies, hazy areas and tonal anomalies, are identifiable in the imagery. There seems to be a strong correlation between the geomorphic/structural and hazy anomalies and known structurally controlled oil and gas fields. The features recognizable on ERTS-1 imagery and their ease of recognition vary from area to area even in imagery acquired at the same time under essentially uniform atmospheric conditions. Repeated coverage is exceedingly valuable in geologic applications. One time complete coverage even for the various seasons does not reveal all the features that ERTS-1 can reveal.

N73-25357*# Tennessee Univ., Knoxville. Dept. of Geography.
GEOGRAPHIC ANALYSIS OF LANDSCAPE CHANGE FROM ERTS-1 IMAGERY Progress Report
John B. Rehder, Principal Investigator Jun. 1973 26 p ref Original contains imagery. Orignal photography may be purchased from the EROS Data Center, 10th and Dakota Avenue, Sioux Falls, S. D. 57198 ERTS
(Contract NAS5-21726)
(E73-10661; NASA-CR-132170) Avail: NTIS HC $3.50 CSCL 08F

There are no author-identified significant results in this report.

N73-25386*# Tennessee Univ., Knoxville. Dept. of Geography.
GEOGRAPHIC ANALYSIS OF LANDSCAPE CHANGE FROM ERTS-1 IMAGERY
John B. Rehder, Principal Investigator Jun. 1973. 1 p ERTS
(Contract NAS5-21726)
(E73-10694; NASA-CR-132998) Avail: NTIS HC $3.00 CSCL 08F

The author has identified the following significant results. Data from low altitude flights and ground truth observations confirm the existence of significant strip mining activity at the Cumberland Plateau, Tennessee Test Site. A map (1:120,000) depicting landscape changes associated with strip mining on the Cumberland Plateau has been completed. The map was prepared from NASA generated RB-57 imagery for April 1972 and ERTS imagery for October 1972. A second map shows the generalized forest cover for the state of Tennessee. The data were derived entirely from five ERTS-1 images and reduced to an original map scale of 1:2.4 million. The most significant discovery concerns the detection, identification, and mapping of plowed fields in northern Alabama, northern Georgia, and southeastern Tennessee. In an April ERTS observation, plowed ground and bare soil surfaces were easily detected and mapped from MSS band 5.

N73-25392*# Texas Instruments, Inc., Dallas.
EVALUATION OF COMMERCIAL UTILITY OF ERTS-A IMAGERY IN STRUCTURAL RECONNAISSANCE FOR MINERALS AND PETROLEUM Progress Report, 1 May - 30 Jun. 1973
Donald F. Saunders, Principal Investigator 9 Jul. 1973 5 p ERTS
(Contract NAS5-21796)
(E73-10700; NASA-CR-133013) Avail: NTIS HC $3.00 CSCL 08G

The author has identified the following significant results. In areas 2 and 3 (Colorado and New Mexico - Texas) continuing correlations are observed between lineaments selected from the ERTS imagery and known fault and fracture zones. There continues to be a correlation between lineament intersectional areas and known mining areas. Initial contacts with mining and/or petroleum companies regarding the use of ERTS-1 imagery as an interpreted medium for guiding reconnaissance operations seems to indicate that the technology and economics will be commercially acceptable for initial investigatory investments.

N73-25411# Bureau of Mines, Washington, D.C.
MINERALS YEARBOOK, 1970. VOLUME 2: AREA REPORTS, DOMESTIC Annual Statistical Report
1972 787 p refs
(PB-214329/5; BM-MYB-170-Vol-2) Avail: NTIS MF $1.45; SOD HC $6.75 as I28.37:97 CSCL 08I

Volume II, Area Reports: Domestic, contains chapters covering the mineral industry of each of the 50 States, the U.S. island possessions in the Pacific Ocean and the Caribbean Sea, the Commonwealth of Puerto Rico, and the Canal Zone. This volume also has a statistical summary chapter and a chapter on employment and injuries. Author (GRA)

N73-26337*# Wolf Research and Development Corp., Pocomoke City, Md.
APPLICABILITY OF SATELLITE REMOTE SENSING FOR MONITORING SURFACE MINING ACTIVITIES Quarterly Progress Report, 8 Mar. - 8 Jun. 1973
R. L. Brooks and J. D. Pennewell 8 Jun. 1973 7 p
(Contract NAS9-13310)
(E73-10731; NASA-CR-133075; QPR-1) Avail: NTIS HC $3.00 CSCL 08I

There are no author-identified significant results in this report.

N73-27252*# Indiana Geological Survey, Bloomington.
APPLICATION OF ERTS-A IMAGERY TO FRACTURE RELATED MINE SAFETY HAZARDS IN THE COAL MINING INDUSTRY Progress Report, Jan. - Jul. 1973
Charles E. Wier, Frank J. Wobber, Principal Investigators (Earth Satellite Corp., Washington, D. C.), R. V. Amato (Earth Satellite Corp., Washington, D. C.), and O. R. Russell Jul. 1973 79 p refs Original contains color imagery. Original photography may be purchased from the EROS Data Center, 10th and Dakota Avenue, Sioux Falls, S. D. 57198 ERTS
(Contract NAS5-21795)
(E73-10776; NASA-CR-133143) Avail: NTIS HC $6.00 CSCL 08I

The author has identified the following significant results. New fracture detail of Indiana has been observed and mapped from ERTS-1 imagery. Studies so far indicate a close relationship between the directions of fracture traces mapped from the imagery, fractures measured on bedrock outcrops, and fractures measured in the underground mines. A seasonal dependence of satellite fracture detection has been established based on vegetational tone differences and solar illumination angle. Numerous image enhancement techniques were tested for improved fracture detection and it was demonstrated that for glacial drift-covered areas of Indiana these techniques were of little value. Manual analysis procedures have, however, been successful. Previously unknown areas of mine subsidence have been observed and field checked. Subsidence-prone areas which are readily detectable on ERTS-1 imagery have been established. A prototype National Mined Lands inventory photomap was made to coincide with the Vincennes 1:250,000 map sheet and distributed to members of Congress and various governmental and mining industry officials. A fracture-lineament map and a mine hazards prediction map are being prepared to classify the test area by the relative potential of rooffall hazrads in future underground mining.

N73-27277*# Earth Satellite Corp., Washington, D.C.
APPLICATION OF EREP IMAGERY TO FRACTURE RELATED MINE SAFETY HAZARDS AND ENVIRONMENTAL PROBLEMS IN MINING Quarterly Progress Report
Charles E. Wier, Frank J. Wobber, Principal Investigators, Roger V. Amato, and Orville R. Russell 17 Jul. 1973 3 p Prepared for Ind. Geol. Surv. EREP
(Contract NAS9-13358)
(E73-10802; NASA-CR-133209; QPR-1) Avail: NTIS HC $3.00 CSCL 08I

There are no author-identified significant results in this report.

N73-27324# Joint Publications Research Service, Arlington, Va.
DEEP-SEATED HEAT FROM THE EARTH
I. M. Dvorov 12 Jul. 1973 148 p refs Transl. into ENGLISH from the book "Glubinnoye Teplo Zemli" Moscow, Nauka, 1972 p 9-104 and 141-205
(JPRS-59496) Avail: NTIS HC $9.50

Basic scientific trends are discussed, such as: regional distribution and conditions of geothermal field formation in a zone accessible to direct measurements; development and improvement of the equipment and procedures in geothermal observations; deep-seated thermal processes; and social-economic utilization of earth's heat. Author

N73-27369# Arizona Univ., Tucson. Office of Arid Lands Studies.
EXPLORATION AND EXPLOITATION OF GEOTHERMAL RESOURCES IN ARID AND SEMIARID LANDS: A LITERATURE REVIEW AND SELECTED BIBLIOGRAPHY
Arid Lands Resource Information Paper No. 2
1973 125 p
(Contract DI-14-31-0001-3729)
(PB-218830/6; W73-07420; OWRR-W-144(2)) Avail: NTIS HC $5.45 CSCL 08G

Contemporary techniques for exploration of geothermal resources are outlined, with particular emphasis on the western U.S. as typical of problems encountered in arid and semiarid lands. These include field reconnaissance, infrared aerial reconnaissance, photogeologic mapping, drilling, geochemical analysis of ground water, application of fluid dynamics to natural steam systems, electrical prospecting, seismic, gravity, and magnetic surveys. Environmental impacts, including noise, odors, subsidence, and legal problems involving developmental regulations, are reviewed. (Author Modified Abstract)

N73-27542# Bureau of Mines, Bartlesville, Okla. Energy Research Center.
THE ASSOCIATION OF AUTOMOTIVE FUEL COMPOSITION WITH EXHAUST REACTIVITY
Basil Dimitriades, B. H. Eccleston, G. P. Sturm, Jr., and C. J. Raible 1973 51 p refs Sponsored in part by EPA
(BM-RI-7756) Avail: NTIS HC $4.75

The association of automotive fuel composition with exhaust reactivity was studied in an experimental program that involved testing with different automotive engines and with gasolines of varied composition. Results showed clearly the exhaust reactivity to increase with increasing levels of polyalkylbenzenes in the fuel. No other systematic patterns of high significance were detected in the association of exhaust reactivity with several broadly defined groups of fuel components. Classification of fuel components in terms of the paraffins-olefins-aromatics groups does not meet the latter requirements. For appropriate classification of fuel components more information is needed on the combustion of hydrocarbons in the multicylinder internal combustion engine. Statistical analysis of the mass emissions data showed significant car and fuel effects on hydrocarbon, carbon monoxide, nitric oxide, total aldehydes, and formaldehyde emission levels and on total photochemical reactivity. Car-fuel interactions were not significant at the 90-pct level. Correlations were found between mass emission parameters and fuel composition. Author

N73-28249* Stanford Univ., Calif. Dept. of Geology.
RELATION OF ERTS-1 DETECTED GEOLOGIC STRUCTURE TO KNOWN ECONOMIC ORE DEPOSITS
Ernest I. Rich *In* NASA. Goddard Space Flight Center Symp. on Significant Results obtained from the ERTS-1, Vol. 1, Sect. A and B 1973 p 395-402 refs Original Contains imagery. Original photography may be purchased from the EROS Data Center, 10th and Dakota Avenue, Sioux Falls, S. D. 57198 ERTS

(Paper-G18) CSCL 08G

A preliminary analysis of ERTS-1 imagery of the Northern Coast Ranges and Sacramento Valley, California, has disclosed a potentially important fracture system which may be one of the controlling factors in the location of known mercury deposits in the Coast Ranges and which appears to be associated with some of the oil and gas fields within the Sacramento Valley. Recognition of this fracture system may prove to be an extremely useful exploration tool, hence careful analysis of subsequent ERTS imagery might delineate areas for field evaluation. Author

N73-28261* Texas Instruments, Inc., Dallas.
EVALUATION OF COMMERCIAL UTILITY OF ERTS-A IMAGERY IN STRUCTURAL RECONNAISSANCE FOR MINERALS AND PETROLEUM
Donald F. Saunders and Gilbert E. Thomas *In* NASA. Goddard Space Flight Center Symp. on Significant Results obtained from the ERTS-1, Vol. 1, Sect. A and B 1973 p 523-530 refs Original contains imagery. Original photography may be purchased from the EROS Data Center, 10th and Dakota Avenue, Sioux Falls, S. D. 57198 ERTS
(Paper-G30) CSCL 08G

Five areas in North America (North Slope-Alaska, Superior Province-Canada, Williston Basin-Montana, Colorado and New Mexico-West Texas) are being studied for discernibility of geological evidence on ERTS-1 imagery. Evidence mapped is compared with known mineral/hydrocarbon accumulations to determine the value of the imagery in commercial exploration programs. Evaluation has proceeded in the New Mexico-West Texas area while awaiting imagery in the other areas. To date, results have been better than expected. Clearly discernible structural lineaments in New Mexico-West Texas are evident on the photographs. Comparison of this evidence with known major mining localities in New Mexico indicates a clear pattern of coincidence between the lineaments and mining localities. In West Texas, lineament and geomorphological evidence obtainable from the photographs define the petroleum-productive Central Basin Platform. Based on evaluation results in the New Mexico-West Texas area and on cursory results in the other four areas of North America, ERTS-1 imagery will be extremely valuable in defining the regional and local structure in any commercial exploration program. Author

N73-28266* Bendix Corp., Ann Arbor, Mich.
ERTS-1 INVESTIGATION OF ECOLOGICAL EFFECTS OF STRIP MINING IN EASTERN OHIO
Philip E. Chase and Wayne Pettyjohn (Ohio State Univ.) *In* NASA. Goddard Space Flight Center Symp. on Significant Results obtained from the ERTS-1, Vol. 1, Sect. A and B. 1973 p 561-568 refs Original contains imagery. Original photography may be purchased from the EROS Data Center, 10th and Dakota Avenue, Sioux Falls, S. D. 57198 ERTS

(Paper-E2) CSCL 08I

Evidence is presented of ERTS capability to detect, map and monitor the effects of strip mining. Both enlarge ERTS imagery and statistically processed outline maps and imagery of stripped earth and standing water are compared to aerial photos of a strip mine near Coshocton, Ohio. The outline maps and decision imagery are at present limited to forming a disruption map of recently mined and unreclaimed earth and the resultant standing water within the mined area. It is planned to prepare a map of the reclaimed areas (reclamation map) within the stripped area and to detect and identify ecological effects such as vegetation kills and stream sedimentation external to the stripped areas. Author

N73-28267* Pennsylvania State Univ., University Park. Office of Remote Sensing of Earth Resources.
THE USE OF ERTS-1 MSS DATA FOR MAPPING STRIP MINES AND ACID MINE DRAINAGE IN PENNSYVANIA
S. S. Alexander, J. Dein, and D. P. Gold *In* NASA. Goddard Space Flight Center Symp. on Significant Results obtained from the ERTS-1, Vol. 1, Sect. A and B 1973 p 569-575 refs erts (For availability see N73-28207 19-13)
(Paper-E3) CSCL 08I

Digital processing of ERTS-I MSS data for areas around the west branch of the Susquehanna River permits identification of stripped areas including ones that are not discernible from visual analysis of ERTS imagery. Underflight data and ground-based observations are used for ground-truth and as a basis for designing more refined operators to make sub-classifications of stripped areas, particularly with regard to manifestations of acid mine drainage; because of associated diagnostic effects on vegetation, seasonal changes in classifiction criteria are being documented as repeated, cloud-free ERTS-I coverage of the same area becomes available. Preliminary results indicate that ERTS data can be used to monitor not only the total extent of stripping in given areas but also the effectiveness of reclamation and pollution abatement procedures. Author

N73-28277* American Univ., Washington, D.C. Dept. of Biology.
DIGITAL ANALYSIS OF POTOMAC RIVER BASIN ERTS IMAGERY: SEDIMENTATION LEVELS AT THE POTOMAC-ANACOSTIA CONFLUENCE AND STRIP MINING IN ALLEGHENY COUNTY, MARYLAND
J. S. Schubert and N. H. MacLeod *In* NASA. Goddard Space Flight Center Symp. on Significant Results obtained from the ERTS-1, Vol. 1, Sect. A and B 1973 p 659-664 ERTS

(Paper-E13) CSCL 08H

Two simple algorithms for classification of sedimentation levels in water and for delineation of active strip mines are in use as part of the development of a more general resource management information system. ERTS MSS CCT's are processed so that each pixel in each channel is geographically referenced and can be accessed individually during whole frame, multi-channel analysis or partial frame analysis. The sedimentation analysis clearly separates classes representing the turbid Anacostia water, the less disturbed Potomac (really), and mud flats resulting from effluent of a major sewage treatment plant. Mud flats of organic or mineral origin are easily distinguished. Author

N73-28319* Pennsylvania State Univ., University Park. Office for Remote Sensing of Earth Resources.
IDENTIFICATION AND MAPPING OF COAL REFUSE BANKS AND OTHER TARGETS IN THE ANTHRACITE REGION
F. Y. Borden, D. N. Thompson, and H. M. Lachowski *In* NASA. Goddard Space Flight Center Symp. on Significant Results obtained from the ERTS-1, Vol. 1, Sect. A and B 1973 p 1067-1074 refs ERTS
(Paper-L24) CSCL 08G

ERTS-1 MSS data covering parts of Pennsylvania's southern and eastern middle anthracite coal fields were studied to determine how well accumulations of coal refuse could be identified and mapped by computer analysis and processing. Spectral signatures of coal refuse targets were similar to water, but had higher reflectances in all channels. Relative reflectances were in the order 4 > 5 > or = 6 > 7. Although no underflight photography was at hand to judge mapping success, correlation was made, with 1:24,000 scale U.S.G.S. maps dated 1947 and 1948. Coal refuse targets correlated well with existing maps. Author

N73-28361* Ohio Dept. of Economic and Community Development, Columbus.
RESOURCE MANAGEMENT IMPLICATIONS OF ERTS-1 DATA TO OHIO
David C. Sweet, Terry L. Wells, and George E. Wukelic (Battelle Columbus Labs., Ohio) *In* NASA. Goddard Space Flight Center Symp. on Significant Results obtained from the ERTS-1, Vol. 1, Sect. A and B 1973 p 1459-1466 Original contains imagery. Original photography may be purchased from the EROS Data Center, 10th and Dakota Avenue, Sioux Falls, S. D. 57198 ERTS
(Paper-R3) CSCL 08F

Initial experimental analysis of ERTS-1 imagery has demonstrated that remote sensing from space is a means of delineating and inventorying Ohio's strip-mined areas, detecting power plant smoke plumes, and proving the data necessary for periodically compiling land use maps for the entire state. The nature and extent of these problems throughout Ohio, how ERTS data can contribute to their solution, and estimates of the long term spgnificance of these initial findings to overall resource management interests in Ohio are summarized. Author

N73-28372* Ohio Univ., Athens. Dept. of Geology.
MAPPING OF SOIL BANKS USING ERTS-1 PICTURES
Moid U. Ahmad, David A. Kantner, and John W. Antalovich (Kucera and Assoc., Inc., Mentor, Ohio) *In* NASA. Goddard Space Flight Center Symp. on Significant Results obtained from the ERTS-1, Vol. 1, Sect. A and B 1973 p 1575-1582 Original contains imagery. Original photography may be purchased from the EROS Data Center, 10th and Dakota Avenue, Sioux Falls, S. D. 57198 ERTS

CSCL 08B

Earth Resources Technology Satellite (ERTS-1) pictures of different wavelengths (MSS 4,5,6,7) were used in the study of two strip mine areas in southeastern Ohio. The first area was near Piedmont Lake and the second area was near New Lexington. Prints were examined under a binocular microscope and the gray tone was correlated with the actual ground conditions at several sites. For the New Lexington area, color infrared pictures taken at an elevation of 18,000 feet were also used for correlation with the ERTS-1 imagery. The results indicate that MSS 5 and 7 are most useful in defining the stripped land and show that the hydrological and soil characteristics are remarkably different than the surrounding lands. Author

N73-28421*# Tennessee Univ., Knoxville. Dept. of Geography.
APPLICATIONS OF ERTS-1 DATA TO LANDSCAPE CHANGE IN EASTERN TENNESSEE
John B. Rehder, Principal Investigator 31 Jul. 1973 13 p refs Proposed for presentation at Symp. on Management and Utilization of Remote Sensing Data, Sioux Falls, S. D., 29 Oct. - 2 Nov. 1973; sponsored by Am. Soc. of Photogrammetry Submitted for publication Original contains imagery. Original photography may be purchased from the EROS Data Center, 10th and Dakota Avenue, Sioux Falls, S. D. 57198 ERTS
(Contract NAS5-21726)
(E73-10843; NASA-CR-133422) Avail: NTIS HC $3.00 CSCL 08F

The author has identified the following significant results. The analysis of landscape change in eastern Tennessee from ERTS-1 data is being derived from three avenues of experimentation and analysis: (1) a multi-stage sampling procedure utilizing ground and aircraft imagery for ground truth and control; (2) a densitometric and computer analytical experiment for the analysis of gray tone signatures and comparisons for landscape change detection and monitoring; and (3) an ERTS image enhancement procedure for the detection and analysis of photomorphic regions. Significant results include: maps of strip mining changes and forest inventory, watershed identification and delimitation, and agricultural regions derived from spring plowing patterns appearing on the ERTS-1 imagery.

N73-29004*# Scientific Translation Service, Santa Barbara, Calif.
EXPERIMENTAL AEROGENERATOR TYPE BEST - ROMANI,

DESCRIPTION, ASSEMBLY, TEST PROGRAM
Washington NASA Aug. 1973 50 p Transl. into ENGLISH of the publ. "Aerogenerateur Experimental Type BEST - Romani description - Montage Programme d'Essai" Paris, Elec. de France, 1958 54 p
(Contract NASw-2483)
(NASA-TT-F-15037) Avail: NTIS HC $4.50 CSCL 10A
The characteristics of a propeller-driven electrical generating machine using wind power are presented. The construction of an installation for the equipment is described. The measurements conducted during the performance tests are analyzed. Author

N73-29008*# Kanner (Leo) Associates, Redwood City, Calif.
OPERATING EXPERIENCE OBTAINED WITH A 100 kW WIND POWER PLANT
U. Huetter Washington NASA Aug. 1973 27 p refs Transl. into ENGLISH from Brennstoff-Waerme-Kraft (Duesseldorf), v. 16, 1964 P333-340
(Contract NASw-2481)
(NASA-TT-F-15068) Avail: NTIS HC $3.50 CSCL 10A
An excerpt is given from the report on experiments and experience associated with the wind power plant and covering design data and those aspects which were decisive in its layout and the type of regulating provisions used, as well as results of the detailed operational tests. The regulating system and the automatic cut-in provisions permit the system to be connected automatically to the public power supply network on the basis of a specific program. The various types of wind conditions considered in designing the power plant are described. Author

N73-29009*# Scientific Translation Service, Santa Barbara, Calif.
THE DEVELOPMENT OF WIND POWER INSTALLATIONS FOR ELECTRICAL POWER GENERATION IN GERMANY
Ulrich Huetter Washington NASA Aug. 1973 32 p refs Transl. into ENGLISH from Z. Brennst.-Waerme-Kraft (Duesseldorf), v. 6, no. 7, 1954 p 270-278
(Contract NASw-2483)
(NASA-TT-F-15050) Avail: NTIS HC $3.75 CSCL 10A
The development of installations for reducing electrical energy from wind energy is beginning in Germany. The wind tower generation installations built by German firms have a wheel area of between 50 to 250 square meters for installed power levels between 3 and 50 kW. In the last 30 years, there has been a tendency to increase the design rotation rate coefficient from 2-4 to a level between 8-16. At the present time, there are reliable installations with nominal power levels between 3 and 22 kW. Successful Danish, American, Russian, and German experiments over prolonged time periods proved that it is possible to operate wind power generation units in parallel with public high-voltage installations without any difficulty. This means that wind energy is now available to satisfy the energy requirement which is continuously increasing all over the world. A rough calculation shows that the energy capacity of the ocean of air is unlimited. Author

N73-29225*# Geological Survey, Washington, D.C. EROS Program Office.
SATELLITE GEOLOGICAL AND GEOPHYSICAL REMOTE SENSING OF ICELAND Special Report No. 1
Richard S. Williams, Jr. and Guomundur Palmason (Natl. Energy Authority, Reykjavik) 1 Aug. 1973 5 p refs Sponsored by NASA ERTS
(E73-10874; NASA-CR-133491) Avail: NTIS HC $3.00 CSCL 08L
There are no author-identified significant results in this report.

N73-29367# Interior Dept., Washington, D.C.
ENVIRONMENTAL STATEMENT FOR THE PROPOSED PROTOTYPE OIL-SHALE LEASING PROGRAM. VOLUME 1: DESCRIPTIONS OF THE REGIONS AND POTENTIAL ENVIRONMENTAL IMPACTS
Sep. 1972 501 p refs
(EIS-AA-72-5242-D-1-Vol-1) Avail: NTIS HC $27.25
The regional environmental impact expected from shale development on private and public lands is examined. A companion document reviews the specific impacts associated with the development of six leases on public lands if the Department of the Interior's proposed prototype oil shale leasing program is implemented. A current state-of-the-art assessment of the technology that may be employed in oil shale development is provided. Included in this assessment are methods of processing; technology related to the management of solid wastes and wastes within the working areas; monitoring methods; and a guide to current research that pertains to the environmental aspects of oil shale development. The regional environmental impact of oil shale development to a maximum cumulative production of 1 million barrels per day by 1985 is described. Author

N73-30311*# Earth Satellite Corp., Washington, D.C. Geosciences and Environmental Applications Div.
STUDY OF APPLICATION OF ERTS-A IMAGERY TO FRACTURE-RELATED MINE SAFETY HAZARDS IN THE COAL MINING INDUSTRY Progress Report, 1 Jul. - 1 Sep. 1973
Charles E. Wier (Indiana Geological Survey), Frank J. Wobber, Principal Investigators, Orville R. Russell, Roger V. Amato, and Thomas Leshendok 10 Sep. 1973 4 p ERTS
(Contract NAS5-21795)
(E73-10970; NASA-CR-133749) Avail: NTIS HC $3.00 CSCL 08I
The author has identified the following significant results. The Kings Station Mine in Gibson County, Indiana has experienced considerable roof fall problems. Detailed fracture mapping of the mine area was done with ERTS-1 and aircraft imagery, and a prediction map of roof problem areas was produced in advance of a visit. The visit to the mine and discussions with the operator indicated that of four zones mapped as potential problem areas, three coincided with areas of excessive roof fall. This positive correlation of 75% lends confidence to the validity of the technique being applied in the investigation. The mine officials expressed an interest in the project and are anxious to see the final product maps which are forthcoming.

N73-30335# Bureau of Mines, Bartlesville, Okla. Energy Research Center.
BUREAU OF MINES ENERGY PROGRAM, 1972
Bill Linville and John D. Spencer 1973 116 p
(BM-IC-8612) Avail: NTIS HC $8.00
Technologies for improving the production and utilization of petroleum, natural gas, and coal were investigated. Topics included are: oil recovery from tar sands, energy relationships, environmental activities, coal storage, preparation and transportation, and in situ processing. The investigations of clean fluid fuels from coal, gas purification, reservoir properties, fly-ash utilization, and coal mine health and safety are also reported. T.M.R.

N73-30976*# Kanner (Leo) Associates, Redwood City, Calif.
PROJECT OF WIND MOTOR WITH AERODYNAMIC TRANSMISSION FOR CAPACITIES OF 100 kw TO 3000 kw
N. V. Krasovskiy Washington NASA Sep. 1973 21 p refs Transl. into ENGLISH from Izv. Otd. Tekh. Nauk, Akad. Nauk SSSR (USSR), no. 5, 1939 p 65-77
(Contract NASw-2481)
(NASA-TT-F-15131) Avail: NTIS HC $3.25 CSCL 10A
To reduce excessive weight requirements in the design of a 100-3000 kw capacity wind motor, aerodynamic transmission is employed. Aerodynamic transmission involves mounting secondary small windmills at the ends of the main wheel blades of the wind motor. The secondary small windmills operate in a high-velocity relative stream of 40-70 m/sec and can produce energy directly from the wind with the windmills turning at 500 or more rpm, with an efficiency of 80 percent or higher. Author

N73-31294*# State of Ohio Dept. of Development, Columbus.
RELEVANCE OF ERTS TO THE STATE OF OHIO Progress Report, Jul. - Aug. 1973
David C. Sweet, Principal Investigator Aug. 1973 33 p ref
Original contains imagery. Original photography may be purchased from the EROS Data Center, 10th and Dakota Avenue, Sioux Falls, S. D. 57198 ERTS
(Contract NAS5-21782)
(E73-10987; NASA-CR-133766) Avail: NTIS HC $3.75 CSCL 08F

The author has identified the following significant results. A significant result was the fabrication of an image transfer and comparison device. To avoid problems and high costs encountered in manual drafting methods, Battelle staff members have fabricated an inexpensive, yet effective, technique for transferring ERTS-1 analysis displays from the Spatial Data 32-Color Viewer to maps and/or aircraft imagery. In brief, the image transfer-comparison device consists of a 2-way mirror which functions similar to a zoom transfer scope. However, the device permits multiuser viewing and real time photographic recording (35-mm and Polaroid) of enhanced ERTS-1 imagery superimposed over maps and aircraft photography. Thirty-five mm, 70 mm, and 4 in. x 5 in. photographs are taken of 80% of the TV screen of the Spatial Data Density Slicing Viewer. The resulting black and white and color imagery is then used in transparent overlays, viewgraphs, 35-mm and 70-mm transparencies, and paper prints for reports and publications. Annotations can be added on the TV screen or on the finished product.

N73-31337*# Wolf Research and Development Corp., Pocomoke City, Md.
APPLICABILITY OF SATELLITE REMOTE SENSING FOR MONITORING SURFACE MINING ACTIVITIES Quarterly Progress Report, 8 Jun. - 8 Sep. 1973
R. L. Brooks, Principal Investigator and J. D. Pennewell 24 Sep. 1973 7 p EREP
(Contract NAS9-13310)
(E73-11033; NASA-CR-133865; QPR-2) Avail: NTIS HC $3.00 CSCL 08I

There are no author-identified significant results in this report.

N73-31338*# Indiana Geological Survey, Bloomington.
STUDY OF APPLICATION OF ERTS-A IMAGERY TO FRACTURE-RELATED MINE SAFETY HAZARDS IN THE COAL MINING INDUSTRY Significant Results Report
Charles Wier, Frank J. Wobber (Earth Satellite Corp., Washington, D. C.), Orville R. Russell, and Kenneth R. Martin, Principal Investigators 28 Sep. 1973 1 p ERTS
(Contract NAS5-21795)
(E73-11034; NASA-CR-133866) Avail: NTIS HC $3.00 CSCL 08I

The author has identified the following significant results. Mined land reclamation analysis procedures developed within the Indiana portion of the Illinois Coal Basin were independently tested in Ohio utilizing 1:80,000 scale enlargements of ERTS-1 image 1029-15361-7 (dated August 21, 1972). An area in Belmont County was selected for analysis due to the extensive surface mining and the different degrees of reclamation occurring in this area. Contour mining in this area provided the opportunity to extend techniques developed for analysis of relatively flat mining areas in Indiana to areas of rolling topography in Ohio. The analysts had no previous experience in the area. Field investigations largely confirmed office analysis results although in a few areas estimates of vegetation percentages were found to be too high. In one area this error approximated 25%. These results suggest that systematic ERTS-1 analysis in combination with selective field sampling can provide reliable vegetation percentage estimates in excess of 25% accuracy with minimum equipment investment and training. The utility of ERTS-1 for practical and reasonably reliable update of mined lands information for groups with budget limitations is suggested. Many states can benefit from low cost updates using ERTS-1 imagery from public sources.

N73-31339*# Geological Survey, Menlo Park, Calif.
IDENTIFICATION OF GEOSTRUCTURES OF CONTINENTAL CRUST, PARTICULARLY AS THEY RELATE TO MINERAL-RESOURCE EVALUATION Progress Report, 1 Jan. - 30 Jun. 1973
George Gryc, Principal Investigator and Ernest H. Lathram 30 Jun. 1973 10 p refs ERTS
(NASA Order S-70243-AG-1)
(E73-11035; NASA-CR-133881) Avail: NTIS HC $3.00 CSCL 08G

The author has identified the following significant results. Analysis of lineated lakes in the Umiat, Alaska area and comparison with known geology, gravity, and magnetic data in the the area suggest concealed structures exist at depth, possibly at or near basement, which may represent targets for petroleum exploration. Compilation of reconnaissance geologic data on 1:250,000 scale enlargements of ERTS-1 images near Corwin reveal structural and stratigraphic anomalies that suggest the Cretaceous sequence is less thick than supposed and is repeated in a series of plates superimposed by flat thrust faults. The structural style differs from that in coeval strata to the north-east, across the northwest-trending linear zone separating differing tectonic styles in older strata noted earlier. The regional extension of a fault known locally in the McCarthy area has been recognized; this fault appears to form the boundary of a significant terrane of mid-Paleozoic metamorphic rocks. ERTS-1 images are being used operationally, at 1:1,000,000 scale in the compilation of regional geologic maps, and at 1:250,000 scale in field mapping in the Brooks Range, in the study of faults in seismically active southern Alaska, in field-checking interpretations previously made from ERTS-1 imagery, and orthophoto base maps for geologic maps.

N73-32229*# Eason Oil Co., Oklahoma City, Okla.
AN EVALUATION OF THE SUITABILITY OF ERTS DATA FOR THE PURPOSES OF PETROLEUM EXPLORATION Progress Report, Jun. - Jul. 1973
Robert J. Collins, Principal Investigator 1 Oct. 1973 2 p ERTS
(Contract NAS5-21735)
(E73-11053; NASA-CR-133934) Avail: NTIS HC $3.00 CSCL 08G

There are no author-identified significant results in this report.

N73-32300# World Meteorological Organization, Geneva (Switzerland).
ENVIRONMENTAL FACTORS IN OPERATIONS TO COMBAT OIL SPILLS
L. Otto 1973 32 p refs
(WMO-359; MAS-9) Avail: NTIS HC $3.75

To combat oil spills effectively, knowledge of the rate and direction of spill movement is required, the latter being determined by winds, waves, and currents, as well as by the physical and chemical properties of oil and water. These aspects are discussed, and factors to be taken into account in developing forecast procedures are also indicated. ESRO

N73-33264*# Pennsylvania State Univ., University Park. Office for Remote Sensing of Earth Resources (ORSER).
MAPPING OF ANTHRACITE REFUSE Interim Report
George J. McMurtry, Gary W. Petersen, Principal Investigators, D. N. Thompson, and F. Y. Borden May 1973 18 p refs ERTS
(Contract NAS5-23133)
(E73-11107; NASA-CR-135575; ORSER-SSEL-TR-20-73) Avail: NTIS HC $3.00 CSCL 08B

There are no author-identified significant results in this report.

N73-33269*# Pennsylvania State Univ., University Park. Space Science and Engineering Lab.
ACID MINE DRAINAGE AND STRIP MINES Interim Report

George J. McMurtry, Gary W. Petersen, Principal Investigators, S. S. Alexander, and J. L. Dein May 1973 8 p ref ERTS (Contract NAS5-23133)
(E73-11112; NASA-CR-135581; ORSER-SSEL-TR-23-73) Avail: NTIS HC $3.00 CSCL 08I

There are no author-identified significant results in this report.

N73-33921# RAND Corp., Santa Monica, Calif.
TRANSPORTATION AND ENERGY
W. E. Mooz Jun. 1973 23 p refs Presented at the 1st Annual Illinois Energy Conf., Chicago, 13-15 Jun. 1973
(Grant NSF GI-44)
(P-5025) Avail: NTIS HC $3.25 CSCL 21D

The use of energy in the transportation sector is discussed. Transportation in the United States presently uses about 25 percent of the total annual energy budget, and the use of energy in the sector is increasing at an average annual rate of about 4 percent per year. Over 95 percent of this energy is supplied by petroleum fuels, and the biggest users are motor vehicles. Differences in modal efficiencies are shown, with motor vehicles and aircraft the least efficient energy users. The growth in energy usė by transportation is shown to be due to increasing modal energy intensiveness, shifts in traffic from low intensiveness modes to high intensiveness modes, and increasing per capita use of transportation. One may expect to see more small cars, shifts from air and highway modes to buses, trains, and pipelines, and changes in personal transportation habits. Author

04 SECONDARY ENERGY SOURCES

Includes hydrogen, methanol, ammonia, synthetic fuels, coal gasification and conversion; bioconversion of organic materials.

A69-21039
COLD HYDROGEN AND BASIC ELECTROLYTE CELLS AT THE RESEARCH CENTER OF THE CGE [LES PILES FROIDES A HYDROGENE ET A ELECTROLYTE BASIQUE AU CENTRE DE RECHERCHES DE LA C. G. E.].
Claude Edon (Compagnie Générale d'Electricité de Paris, Centre de Recherches, Marcoussis, Essonne, France).
IN: ELECTROCHEMICAL GENERATORS FOR SPACE APPLICATIONS; CENTRE NATIONAL D'ETUDES SPATIALES, INTERNATIONAL CONVENTION, PARIS, FRANCE, DECEMBER 4-7, 1967, PROCEEDINGS [LES GENERATEURS ELECTROCHIMIQUES POUR APPLICATIONS SPATIALES; CENTRE NATIONAL D'ETUDES SPATIALES, COLLOQUE INTERNATIONAL, PARIS, FRANCE, DECEMBER 4-7, 1967, PROCEEDINGS].
Paris, Dunod Editeur, 1968, p. 57-70. In French.

Discussion of the development of fuel cells based on a study of the composite subsystems - e.g., single cell batteries, reagent chambers, and auxiliary control systems. The development of a cold hydrogen and basic electrolyte cell is described on the basis of the following parameters: (1) atonomy, weight, and reliability of the batteries, (2) low-power cells and operation in air, (3) power of the cell and regulation of the electrolyte concentration, and (4) reliability, output, and weight of the auxiliary control systems.
M. G.

A69-43725 #
ACTIVE COOLING OF A HYDROGEN-FUELED SCRAMJET ENGINE.
L. L. Pagel and W. R. Warmbold (McDonnell Douglas Corp., McDonnell Aircraft Co., St. Louis, Mo.).
(American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 5th, Philadelphia, Pa., Oct. 21-24, 1968, Paper 68-1091.)
Journal of Aircraft, vol. 6, Sept.-Oct. 1969, p. 472-474.

Analytical studies were performed to determine engine cooling requirements for a scramjet powered, high-altitude cruise aircraft. A comparison of active cooling concepts resulted in the selection of a regenerative system using superalloy heat exchangers and the hydrogen fuel as coolant. This approach resulted in efficient operation (i. e., equivalence ratios of less than one) at flight speeds of Mach 12 or greater. Internal aerodynamic heating rates were predicted by the reference enthalpy turbulent heating correlation and increased locally to account for shock/boundary layer interaction effects. Coolant side heat transfer analyses were performed to determine near optimum heat exchanger core geometry. Sensitivity studies established the relationship between engine cooling requirements and key parameters for a representative aircraft.
(Author)

A70-31851 * # **Hypersonic aircraft technology and applications.** A. J. Eggers, Jr., N. B. Cohen (NASA, Washington, D.C.), and R. H. Petersen (NASA, Ames Research Center, Moffett Field, Calif.). *Astronautics and Aeronautics*, vol. 8, June 1970, p. 30-41. 31 refs.

Discussion of hypersonic aircraft technology giving particular attention to a long-range transport and to a reusable launch vehicle. The study of hypersonic commercial transports indicates that hypersonic aircraft cruising at about Mach 6 can carry large payloads over long ranges. The advantages of liquid hydrogen as a fuel are pointed out. The effect of size on hypersonic-transport payload is investigated. An airbreathing booster and rocket-powered orbiter stage at Mach 10, in an artist's concept of a shuttle operation is shown. Propulsion system technology is considered. For Mach numbers above about 8, the scramjet offers the most promising approach.
G.R.

A70-44127 * # **New approaches to hypersonic aircraft.** John V. Becker (NASA, Langley Research Center, Aero-Physics Div., Hampton, Va.). *International Council of the Aeronautical Sciences, Congress, 7th, Rome, Italy, Sept. 14-18, 1970, Paper ICAS 70-16.* 28 p. 31 refs.

The strong interactions between the aerodynamic, structural, and propulsive systems of hypersonic air breathers offer important opportunities for achieving improved vehicles. One of the most promising is the use of the hydrogen fuel heat sink to provide cooling of major areas of the airframe. This possibility is explored in some detail, with considerations of the theoretical possibilities, engine designs for minimum cooling, comparative analysis of candidate high-level cooling systems, recent fluid-mechanical studies of slot cooling, structural designs compatible with practical cooling systems, and aerodynamic features made possible in actively cooled vehicles. The results suggest that hypersonic cruise vehicles constructed of largely unshielded aluminum or titanium alloys are feasible and offer a number of advantages. Further studies of the problems and possibilities of this category of hypersonic vehicles are suggested.
(Author)

A71-44365 **Liquid hydrogen as a fuel for the future.** Lawrence W. Jones (Michigan, University, Ann Arbor, Mich.). *Science*, vol. 174, Oct. 22, 1971, p. 367-370. 13 refs.

The use of liquid hydrogen as a long-term replacement for hydrocarbon fuel for land and air transportation seems technically feasible. It is an ideal fuel from the standpoint of a completely cyclic system, serving as a 'working substance' in a closed chemical and thermodynamic cycle. The energy-per-unit-weight advantage over gasoline or any other hydrocarbon fuel makes liquid hydrogen particularly advantageous for aircraft and long-range land transport. As a pollution-free fuel, it must be seriously considered as the logical replacement for hydrocarbons in the 21st century.
G.R.

A72-26186 # **Fabrication and preliminary testing of a 3kW hydrogen resistojet.** J. A. Donovan, W. T. Lord, and P. J. Sherwood (Rocket Propulsion Establishment, Westcott, Bucks., England). *American Institute of Aeronautics and Astronautics, Electric Propulsion Conference, 9th, Bethesda, Md., Apr. 17-19, 1972, Paper 72-449.* 16 p. 20 refs. Members, $1.50; nonmembers, $2.00.

Description of a hydrogen resistojet incorporating a rhenium heat exchanger and nozzle, with target performance (total power 3.34 kW, overall efficiency 0.790, exhaust velocity 8.09 km/sec) appropriate for the transfer of geostationary communications satellites. The successful fabrication of two such resistojets from two sets of rhenium components is described, and test results are presented and compared with theory. Although a fully welded construction was not achieved, no deleterious effects were observed and the results, which have a high degree of resolution, are self-consistent and conform to theoretical trends. The prospects for the tests at design conditions are therefore encouraging.
(Author)

A72-26754 **Energy characteristics of a coaxial plasma source.** A. G. Belikov, V. P. Goncharenko, D. K. Goncharenko, N. T. Derepovskii, B. G. Safronov, and N. A. Khizhniak. *(Zhurnal Tekhnicheskoi Fiziki*, vol. 41, Sept. 1971, p. 1881-1886.) *Soviet Physics - Technical Physics*, vol. 16, Mar. 1972, p. 1488-1491. 5 refs. Translation.

Description of a coaxial plasma source designed for studying the energetic characteristics of plasmas. The electrodes of the source are 70 cm long and 3 and 14 cm in diameter, and are separated by a plastic insulator. A pulsed electromagnetic valve is used for gas admission through three transverse slots in the electrode body. A 60-microfarad capacitor battery is used for discharges lasting from 14 to 20 microsec. Plasmoids with energies in excess of 1 kJ are obtained in the source. A linear dependence of the plasmoid energy on the battery-stored energy is established. Fast pure-hydrogen plasmoids can be obtained in the source.
V.Z.

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A73-37498 * # **Turbojet emissions - Hydrogen versus JP.** J. Grobman, C. Norgren, and D. Anderson (NASA, Lewis Research Center, Cleveland, Ohio). *Working Symposium on Liquid-Hydrogen-Fueled Aircraft, Hampton, Va., May 15, 16, 1973, Paper.* 22 p. 20 refs.

Preliminary data from an experimental combustor show that the NO sub x emission index, g (NO2)/kg fuel, is about three times greater for hydrogen than for JP at simulated cruise conditions. However, if these results are applied to aircraft designed for a given mission, hydrogen's higher heating value enables the aircraft to have a lower gross weight and a lower fuel flow rate so that the NO sub x emission rate, kg(NO2)/hr may be reduced about 30% compared to JP. Theoretical kinetics calculations indicate that combustors may be designed for hydrogen that could further decrease NO sub x emissions by taking advantage of hydrogen's wide flammable limits and high burning velocity. (Author)

A73-38413 * # **Electrolytic hydrogen fuel production with solid polymer electrolyte technology.** W. A. Titterington and A. P. Fickett (General Electric Co., Lynn, Mass.). In: Intersociety Energy Conversion Engineering Conference, 8th, Philadelphia, Pa., August 13-16, 1973, Proceedings. (A73-38386 19-03) New York, American Institute of Aeronautics and Astronautics, Inc., 1973, p. 574-579. 6 refs. NASA-Navy-USAF-supported research.

A water electrolysis technology based on a solid polymer electrolyte (SPE) concept is presented for applicability to large-scale hydrogen production in a future energy system. High cell current density operation is selected for the application, and supporting cell test performance data are presented. Demonstrated cell life data are included to support the adaptability of the SPE system to large-size hydrogen generation utility plants as needed for bulk energy storage or transmission. The inherent system advantages of the acid SPE electrolysis technology are explained. System performance predictions are made through the year 2000, along with plant capital and operating cost projections. (Author)

A73-38436 * # **H2-O2 auxiliary power unit for Space Shuttle vehicles - A progress report.** J. P. Joyce, D. G. Beremand, H. M. Cameron, and K. S. Jefferies (NASA, Lewis Research Center, Cleveland, Ohio). *AIAA, AIChE, ANS, ASME, IEEE, SAE, and ACS, Intersociety Energy Conversion Engineering Conference, 8th, University of Pennsylvania, Philadelphia, Pa., Aug. 13-16, 1973, Paper 739028.* 9 p. 5 refs.

Description of a program to establish technology readiness of hydrogen-oxygen (H2-O2) auxiliary power units for use on board the Space Shuttle orbiter vehicle. Fundamental objectives include experimentally establishing an acceptable propellant flow control method, verification of combustor stability, and adequate thermal management. An initial auxiliary power unit (APU) configuration with recycled hydrogen flow has been studied and revised toward greater simplicity and scaling ease. The selected APU is a recuperated open-cycle, turbine-driven unit. Series flow of cryogenic hydrogen removes internally-generated heat and heat from the hydraulic system. The revised configuration schematic and its calculated performance are reviewed. A weight comparison is made between the shuttle baseline hydrazine and H2-O2 APU systems, showing that hydrogen-oxygen APUs have the potential of increasing the payload of the Space Shuttle. (Author)

A73-45025 **Fuel and hydrogen cells (Les piles à combustible et l'hydrogène).** Y. Breelle, A. Grehier, and J. Chéron (Institut Français du Pétrole, des Carburants et Lubrifiants, Paris, France). *Sciences et Techniques,* Sept. 15, 1973, p. 5-15. In French.

The hydrogen cell is promising because it appears to be the only one capable of satisfying the criteria of price, mass output, fuel cost, and availability of materials necessary for access to important outlets. The technical level achieved by this cell should make it possible to undertake a large program of evaluation of the problems posed by the use of hydrogen for generators, automotive power, power plants, and oceanography. Within the economic context of energy sources and distribution, it is possible to foresee a progressive change from fossil fuel plants to nuclear plants. F.R.L.

N68-12434# Bureau of Mines, Washington, D. C.
INITIATION OF SPHERICAL DETONATION IN ACETYLENE–OXYGEN MIXTURES
Elton L. Litchfield, Marilyn H. Hay, and David J. Cohen Dec. 1967 11 p refs
(BM-RI-7061)

The Bureau of Mines determined minimum energies for direct initiation of expanding gaseous detonation waves in acetylene–oxygen mixtures. Composition limit ranges for the initiation of detonation with fixed energies have been compared to data in the literature. Assuming that the stored electrical energy is completely converted to thermal energy, the agreement between the energy of primary explosive initiators and the energy of electrical discharge initiators was good. Minimum energies for initiation of detonation in the most sensitive composition (40 percent C_2H_2 plus 60 percent O_2) were: 0.64 joule at an initial pressure of 1/4 atmosphere, 5.0×10^{-2} joule at 1/2 atmosphere, and 3.7×10^{-3} joule at 1 atmosphere. Fuel concentrations in mixtures initiated to detonation by 4.9×10^{2} joules ranged from 10 to 65 percent C_2H_2 at 1/4 atmosphere, 10 to 67 percent C_2H_2 at 1/2 atmosphere, and 9 to 68 percent C_2H_2 at 1 atmosphere. Author

N68-24657*# National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio.
ENERGY REQUIRED FOR PROTON PRODUCTION BY ELECTRON IMPACT IN MIXTURES OF ATOMIC AND MOLECULAR HYDROGEN
George M. Prok and Carl F. Monnin Washington 1967 18 p refs Presented at 9th Ann. Meeting of the Plasma Phys. Div. of the Am. Phys. Soc., Austin, Tex., 8-11 Nov. 1967
(NASA-TM-X-52344) CSCL 20H

Energy required for proton and molecular hydrogen ion production by electron impact was calculated for a tenuous hydrogen plasma. The cost was determined for various degrees of dissociation from 0 to 100 percent. The model assumed was a Maxwellian electron gas, in the temperature range of 3 to 100 eV, interacting with cold ground state neutrals. The concentration of the 2s metastable state of atomic hydrogen is shown to be negligible for the cost calculations. The cost decreases sharply with the degree of dissociation, and at energies between 40 and 100 eV and dissociation greater than 5 percent. The results for the monoenergetic case and Maxwellian case agreed to within about 6 percent. At 25 percent dissociation, the proton production cost is about a factor of three greater than that in atomic hydrogen. When the degree of dissociation is 40 percent, the proton production cost is only a factor of two greater than in atomic hydrogen, but it is nearly three orders of magnitude less than in molecular hydrogen. Author

N69-29919# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
ENERGY SOURCES IN AIRCRAFT ENGINES
Pin-Chuan Chang 9 Oct. 1968 7 p Transl. into ENGLISH from Hang Kung Chih Shih (China), no. 7, 1960 p 16
(AD-685535; FTD-HT-23-584-68) Avail: CFSTI CSCL 1/3

After reviewing the properties and limitations of chemical fuels such as gasoline, solid fuel and hydrogen fuel, the report discusses the possibilities of ionic fuel and nuclear fuel, and their existing problems of application to aviation. It is stressed that due to the fast scientific progress and requirements, these pending problems may soon be solved. Author (TAB)

N70-10884# Akademiya Nauk URSR, Kiev.
GASIFICATION OF COAL ENRICHMENT WASTES
S. G. Vesselman, L. V. Drobyshev, and N. Ye. Luginin *In its*

Processes of Combust. and Heat Treat. of Mater. 1967 p 56 - 62 refs In RUSSIAN
Avail: CFSTI

Coal enrichment wastes with a low yield of volatile materials were separated by specific weight and subjected to gasification in an air blast gas generator. Gas samples were withdrawn from the lower section of the fuel layer at some distance from the fire grate and temperature measurements were made periodically at a specific time to determine the thickness of the layer. The experiments show that coal enrichment wastes are suitable raw materials for extracting fuel gas. The temperature of the fuel layer in the generator should not exceed the softening temperature of the ash, and both the temperature and thickness of the fuel layer should be increased to improve the quality of the extracted gas. The rate of gasification does not depend on the ash content of the waste materials. Transl. by R.B.

N70-10886# Akademiya Nauk URSR, Kiev.
THE DEPENDENCE OF GAS PRODUCTION COSTS ON THE DEGREE OF OXYGEN BLAST ENRICHMENT DURING GASIFICATION OF LIGNITE UNDER PRESSURE
G. N. Khopta *In its* Processes of Combust. and Heat Treat. of Mater. 1967 p 63 - 67 refs In RUSSIAN

Avail: CFSTI

On the basis of experimental studies, capital outlays to equip gas works of identical thermal output with gas are hardly dependent on the degree of oxygen blast enrichment and they reach a minimum when oxygen content in the blast is 60%. Operational expenditures for producing a thermal unit of gas increase as the oxygen content in the blast increases. Minimum expenditures are required for air enriched gas and comprise 9.8 million rubles, which is 10% less than those required for oxygen enriched gas. Fuel expenditures for power requirements increase as oxygen concentration in the blast increases, and, with 100% oxygen enrichment, they exceed the fuel expenditure level by 74% compared to the power requirements for air enrichment. Transl. by R.B.

N70-14509# Lobo (Walter E.), New York.
ACETYLENE AND LOW COST POWER
Walter E. Lobo *In* AEC Abundant Nucl. Energy May 1969 p 83 - 92 refs
Avail: CFSTI

The various processes for the manufacture of acetylene are briefly reviewed with particular emphasis on those processes that use electrical energy as the main energy source. The cost of energy, although important, is not considered a large enough factor that low-cost power would revolutionize the acetylene-production picture. Author (NSA)

N70-14511# Oak Ridge National Lab., Tenn.
THE ECONOMICS OF HYDROGEN AND OXYGEN PRODUCTION BY WATER ELECTROLYSIS AND COMPETITIVE PROCESSES
J. E. Mrochek *In* AEC Abundant Nucl. Energy May 1969 p 107 - 122 refs
Avail: CFSTI

The manufacturing costs of hydrogen and oxygen are estimated for water-electrolysis plants using two types of advanced electrolytic cells: porous-electrode cells and high-temperature vapor-phase cells. Electrolytic plants producing 40 million standard cubic feet of hydrogen and 860 tons of oxygen per day are compared with fossil-fuel plants that use steam reforming and partial-oxidation processes at the same hydrogen-production rates. The cost of electricity required for the electrolytic process using a porous-electrode cell to break even with the fossil-fuel processes ranged from 0.8 to 2.3 mills/kw-hr. If an oxygen credit of $4/ton was assumed, this break-even power cost range increased to 1.5 to 3 mills/kw-hr. The use of electrolytic hydrogen plants as load-leveling devices for power plants is discussed briefly. Author (NSA)

N70-14512# Tennessee Valley Authority, Muscle Shoals, Ala.
PRODUCTION OF AMMONIA USING LOW-COST NUCLEAR ENERGY
Glenn M. Blouin *In* AEC Abundant Nucl. Energy May 1969 p 123 - 134 refs
Avail: CFSTI

It is postulated that expected near-term (10-yr) advances in nuclear electrical power stations and in hydrogen electrolysis cells will reduce costs to the point where electrolytic ammonia will be competitive in areas where conventional hydrocarbon feedstocks must be imported. Furthermore, far-term (20-yr) advances in reactor and electrolysis-cell technology could result in significant economic advantages over conventional ammonia processes. Author (NSA)

N70-18542# Federal Aviation Administration, Washington, D.C. Office of Supersonic Transport Development.
FUEL CONSIDERATIONS IN THE US SUPERSONIC TRANSPORT PROGRAM
Joseph C. Saia 24 Oct. 1968 28 p refs Presented at the Jet Fuel Quality Symp., San Antonio, 22-24 Oct. 1968
(AD-696588) Avail: CFSTI CSCL 21/4

The type of fuel selected for use in the United States Supersonic Transport (SST) is commercial Jet A kerosene. The importance of the fuel cost factor in SST direct operating cost, and the reasons for excluding the use of commercial Jet B aviation turbine fuel for the SST, are briefly discussed in this paper. A general description of the SST aircraft and engine fuel systems, and the typical environmental conditions to which the fuel will be exposed, are included. The SST fuels test programs are summarized. Author (TAB)

N70-20511# Bureau of Mines, Bartlesville, Okla. Petroleum Research Center.
INFLUENCE OF VOLATILE FUEL COMPONENTS ON VEHICLE EMISSIONS
B. H. Eccleston, B. F. Noble, and R. W. Hurn Feb. 1970 85 p refs
(BM-RI-7291) Avail: Issuing Activity

The effect of fuel volatility and front-end fuel composition on the amount and photochemical reactivity of automobile exhaust and fuel system evaporative emissions was studied. The study involved six gasolines: the base fuel, three fuels of varied volatility, and two fuels differing from the base and from each other in front-end olefin content. Data were obtained from 16 vehicles operated on a chassis dynamometer using a speed-load-time cycle that approximated a typical urban trip. Tests were made at ambient temperatures using a climate-controlled dynamometer room. The amount of hydrocarbon emission and its probable photochemical effect is expressed as weight of a moderately reactive material, ethylene. Emissions of oxides of nitrogen, carbon monoxide, and aldehydes were also observed. Results show that reduction of volatility from typical levels reduces both the amount and the reactivity equivalent of evaporative losses with a slight increase in exhaust emissions. Alternatively, reducing the amount of light olefin in the fuel had no effect on the amount of hydrocarbon pollutant but did significantly reduce the reactivity equivalent of the emissions. Neither volatility change nor chemical changes to the fuel significantly affected the nonhydrocarbon emissions. Author

N70-42326*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
THERMAL FEASIBILITY OF USING METHANE OR HYDROGEN FUEL FOR DIRECT COOLING OF A FIRST-STAGE TURBINE STATOR
Raymond S. Colladay Washington Oct. 1970 25 p refs
(NASA-TN-D-6042; E-5701) Avail: NTIS CSCL 20M

The feasibility of cooling the first-stage turbine stator directly with cryogenic fuels was investigated based on a numerical heat transfer analysis of methane and hydrogen-cooled vanes. An insulation barrier between the fuel cooling passages and the external vane surface was required to prevent adverse cooling conditions. The cooling configuration analyzed was that of tubular cooling passages embedded in insulation material surrounded by an outer vane shell. The results indicate that the turbine stator vanes could be adequately cooled with methane or hydrogen fuel at a 2490 F (1639 K) local-hot-spot gas temperature. Author

N71-19463*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
CRYOGENIC FUELS FOR AIRCRAFT
Jack B. Esgar *In its* Aircraft Propulsion 1971 p 397-420 refs

Avail: NTIS HC$6.00/MF$0.95 CSCL 21D
Exploratory research on the use of cryogenic fuels for airbreathing gas turbine engines is presented. The two prime reasons for the interest in cryogenic fuels for advanced aircraft are the higher heating value per pound of fuel and the heat sink capacity that is available in this fuel for cooling hot components in the engine or the aircraft. The possible applications of liquid methane to a supersonic transport type aircraft and the application of liquid hydrogen to the airbreathing engines for recoverable boosters and orbiters for the space shuttle are discussed. Author

N72-18520# Energy Research Corp., Bethel, Conn.
HYDROGEN GENERATOR ASSEMBLIES Final Report, Mar. 1970 - Mar. 1971
Richard Engdahl and E. S. Tillman, Jr. Sep. 1971 70 p refs
(Contract DAAB07-70-C-0153; DA Proj. 1G6-63702-DG-10)
(AD-733931; ECOM-0153-F) Avail: NTIS CSCL 13/7
The objective of the work was to evaluate design criteria for a simplified hydrogen generator for a 500 watt fuel cell. The hydrogen is produced by the catalytic steam reforming of vaporized JP-4 fuel with subsequent purification through a palladium-silver separator. The experimental studies were performed on a breadboard type system. This system contained all of the major sub-components required in an actual portable unit for field use. GRA

N72-18911*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
STRUCTURAL WEIGHT ANALYSIS OF HYPERSONIC AIRCRAFT
Mark D. Ardema Washington Mar. 1972 50 p refs
(NASA-TN-D-6692; A-3905) Avail: NTIS CSCL 20K
The weights of major structural components of hypersonic, liquid hydrogen fueled aircraft are estimated and discussed. The major components are the body structure, body thermal protection system tankage and wing structure. The method of estimating body structure weight is presented in detail while the weights of the other components are estimated by methods given in referenced papers. Two nominal vehicle concepts are considered. The advanced concept employs a wing-body configuration and hot structure with a nonintegral tank, while the potential concept employs an all body configuration and cold, integral pillow tankage structure. Characteristics of these two concepts are discussed and parametric data relating their weight fractions to variations in vehicle shape and size design criteria and mission requirements, and structural arrangement are presented. Although the potential concept is shown to have a weight advantage over the advanced, it involves more design uncertainties since it is farther removed in design from existing aircraft. Author

N73-33738# Atomic Energy Commission, Washington, D.C.
HYDROGEN AND OTHER SYNTHETIC FUELS: A SUMMARY OF THE WORK OF THE SYNTHETIC FUELS PANEL
Sep. 1972 135 p refs
(TID-26136) Avail: NTIS MF $1.45; SOD HC $2.25
The development of hydrogen as a synthetic fuel is attractive because it is essentially clean burning, the main combustion product being water; it may be substituted for nearly all fuel uses; it can be produced from domestic resources; it is available from a renewable and universal raw material-water; and nearly all primary energy sources, nuclear, solar, etc., may be used in its production. The main obstacles to the use of hydrogen as a universal fuel are its high cost relative to the current low prices for fossil fuels and, for some applications, the unresolved problems of handling a low-density or a cryogenic fluid. Safety considerations are discussed. The various options for the production of hydrogen, namely, electrolysis, thermochemical, biological, radiolytic, and various combinations, and the production of other synthetic fuels, particularly those made from hydrogen are discussed. Other synthetic fuels considered include ammonia (NH3), hydrazine (N2H4), methanol (CH3OH), methane (CH4), ethanol (C2H5OH), and gasoline (C8H18). NSA

05 ENERGY CONVERSION

Includes photovoltaic power conversion; superconductive or cryogenic systems for electric production; electromagnetic wave energy conversion; plasmas and magnetohydrodynamics; fuel cells; thermionic or thermoelectric conversion; liquid metal conversion; and thermomechanical energy conversion using Brayton cycle (gas turbines or gas turbine engines), Rankine or Stirling cycles, topping or bottoming cycles.

A68-10231
RADIOISOTOPE POWER SUBSYSTEMS FOR SPACE APPLICATION.
D. F. Berganini and E. T. Mahefkey, Jr. (USAF, Systems Command, Research and Technology Div., Aero Propulsion Laboratory, Aerospace Power Div., Wright-Patterson AFB, Ohio).
IN: INTERNATIONAL SYMPOSIUM ON SPACE TECHNOLOGY AND SCIENCE, 6TH, TOKYO, JAPAN, NOVEMBER 29-DECEMBER 4, 1965, PROCEEDINGS.
Edited by Daikichiro Mori.
Tokyo, AGNE Publishing, Inc., 1966, p. 553-562. 7 refs.
Examination of current and projected performance capabilities of radioisotope power subsystems for space applications. The isotope subsystem is not affected by orbital dark time as are the solar energy concepts; current technology allows routine heat source operation in the 500 to 750°C regime. Isotope heat source design considerations are discussed, and power conversion methods (thermoelectric, thermionic, Rankine cycle, and Brayton cycle) are considered. The Brayton cycle offers the highest efficiency of all the dynamic schemes investigated, providing that heat source designs can be evolved to provide turbine inlet temperatures of 2000°R. B.B.

A68-11240 #
DIRECT CONVERSION OF THERMAL ENERGY TO ELECTRIC ENERGY - THERMOELECTRIC CONVERSION [LA CONVERSION DIRECTE DE L'ENERGIE THERMIQUE EN ENERGIE ELECTRIQUE - LA CONVERSION THERMOELECTRIQUE].
Bernard Lespinasse (Institut National des Sciences Appliquées, Lyons, France).
Sciences et Industries Spatiales, vol. 3, no. 9-10, 1967, p. 43-54. 14 refs. In French.
Consideration of the conversion of thermal energy into electric energy by means of a thermoelectric converter or generator (the only method of converting from thermal energy to electric energy that has actually been used in space). The thermoelectric converter consists of a group of thermocouples placed between a heat source and a radiator feeding a cold source. The hot junctions are generally heated by an isotopic source or, more rarely, by the cooling fluid of a nuclear reactor. This source could also be solar energy concentrated in the focus of a mirror. Thermoelectric processes, Kelvin relationships, efficiency of a thermocouple, and choice of materials are discussed. The SNAP-3, SNAP-9, and SNAP-10A isotopic generators are cited as examples of such space-power systems. The efficiency of thermoelectric converters is low, and their use is limited to low powers. F.R.L.

A68-11941 #
INFINITELY SEGMENTED ELECTRODES - MAGNETOTHERMOELECTRIC DEVICES.
Ozer A. Arnas (Louisiana State University, Mechanical Engineering Dept., Baton Rouge, La.).
American Society of Mechanical Engineers, Winter Annual Meeting, Pittsburgh, Pa., Nov. 12-17, 1967, Paper 67-WA/ENER-2. 7 p. 13 refs.
Members, $0.75; nonmembers, $1.50.
Analysis of the performance and characteristics of magnetothermoelectric direct energy-conversion devices with "infinitely segmented" electrodes. This analysis is based on the nonequilibrium thermodynamic analysis of the mechanics of transport processes taking place in a solid due to simultaneous flow of thermal and electrical currents in the presence of externally applied magnetic fields. In the case of the magnetothermoelectric generator, results pertaining to power developed, thermal efficiency, and the optimum values of these parameters are presented. In the case of the magnetothermoelectric cooler, results pertaining to induced temperature difference, coefficient of performance, and the optimum values of these parameters are presented. M.F.

A68-12258 #
A GRAPHICAL PRESENTATION OF MAGNETOGASDYNAMIC ACCELERATOR AND GENERATOR PERFORMANCE CHARACTERISTICS.
W. L. Powers (Augusta College, Physics Dept., Augusta, Ga.), J. B. Dicks, and W. T. Snyder (Tennessee, University, Space Institute, Tullahoma, Tenn.).
AIAA Journal, vol. 5, Dec. 1967, p. 2232-2236. 8 refs.
Contract No. AF 33(615)-2691.
Graphical display of the generalized Ohm's law which is assumed to describe the local electrical characteristics of MGD accelerators and generators. Dimensionless electric fields and current densities are defined which simplify the problem and allow a dimensionless power density and a scaled efficiency to be written and presented on a performance map. The operating features of the continuous electrode, Faraday, diagonal conducting wall, and Hall accelerators and generators are represented on the same map for purposes of comparison. The operating equations pertinent to each of the special devices are also written with more emphasis given to the diagonal conducting wall device. It is shown how this map may be used in evaluating MGD channel performance, and how it materially aids in channel design and in selecting the most desirable type of device for a given requirement. (Author)

A68-12962 #
THERMIONIC POWER GENERATION.
L. G. Sanders (United Kingdom Atomic Energy Authority, Atomic Energy Research Establishment, Harwell, Berks., England).
IN: ADVANCED ELECTRONIC TECHNIQUES; PROCEEDINGS OF THE SECOND OXFORD LECTURE COURSE, OXFORD, ENGLAND, JULY 1966.
Lecture Course sponsored by Electronic Components and Instrument Practice.
Edited by G. W. A. Dummer.
London, United Trade Press, Ltd., 1967, p. 132-142.
Outline of the general principles of thermionic power generation. Neutralization and the unignited and ignited modes of a thermionic converter are discussed. The observed performance from a practical converter is considered, and values representing its performance with a Mo emitter and Ni collector are plotted. Electically heated converters and flame and fission heat sources are investigated. B.B.

A68-13240
HYDRAZINE-AIR FUEL CELLS.
George E. Evans (Union Carbide Corp., Parma Technical Center, Fuel Cell Dept., Parma, Ohio) and Karl V. Kordesch (Union Carbide Corp., Parma Technical Center, Parma, Ohio).
Science, vol. 158, Dec. 1, 1967, p. 1148-1152. 17 refs.
Description of the construction and performance characteristics of hydrazine-air fuel cells. In these cells the hydrazine fuel is supplied as a dilute solution of hydrazine in a circulating "anolyte" consisting of an approximately 9N solution of KOH in water. A portion of the dissolved hydrazine in the anolyte diffuses into a porous conductive anode, where it reacts electrochemically to produce nitrogen, water, and electrons. The water and bubbles of gaseous nitrogen are swept away in the circulating anolyte, while the electrons flow from the anode by way of metallic current collectors to the external load circuit. The hydroxyl ions consumed in the anode reaction are supplied by a KOH electrolyte immobilized in a microporous matrix (usually asbestos) positioned between the electrodes. P.v.T.

A68-14136
THERMOELECTRIC RADIOISOTOPE GENERATORS [GENERATEURS THERMOELECTRIQUES A RADIOISOTOPES].

H. J. Albany (Commissariat à l'Energie Atomique, Centre d'Etudes Nucléaires de Saclay, Service d'Electronique Physique, Gif-sur-Yvette, Hauts-de-Seine, France).
Entropie, no. 17, Sept.-Oct. 1967, p. 79-83. 6 refs. In French.

Study of phenomena serving as the basis for thermoelectric conversion of energy and examination of the factors determining generator performance. Selection criteria for radioisotopes as sources of energy are given, with a review of the characteristics of some of these compounds. The possibilities of using thermoelectric radioisotope converters as power generators in spatial, terrestrial, oceanographic, and medical fields are emphasized. The development and achievements of these generators within the last few years are reviewed. M.F.

A68-14861 #

CONVENTIONAL AND "EXOTIC" ELECTROCHEMICAL ENERGY GENERATORS [GENERATEURS D'ENERGIE D'ORIGINE ELECTROCHIMIQUE CLASSIQUES ET "EXOTIQUES"].
J.-F. Laurent (Société des Accumulateurs Fixes et de Traction, Poitiers, France).
(Société Française des Electriciens, Meeting, France, Feb. 21, 1967, Communication.)
Revue Générale de l'Electricite, vol. 76, Nov. 1967, p. 1397-1405. In French.

Discussion of the operating principles of conventional and "exotic" electrochemical generators. The main types of primary, secondary, and energizable generators are listed, and their major advantages are discussed. The requirements to be met by all energy sources of electrochemical origin are reviewed. The main characteristics of conventional and exotic galvanic cells are studied, and the importance of solvent electrical activity is stressed. The possibilities of future applications are considered. M.F.

A68-15139

EXPLOSIVE GENERATORS.
E. I. Bichenkov (Akademiia Nauk SSSR, Sibirskoe Otdelenie, Institut Gidrodinamiki, Novosibirsk, USSR).
(Akademiia Nauk SSSR, Doklady, vol. 174, June 1, 1967, p. 779-782.)
Soviet Physics - Doklady, vol. 12, Dec. 1967, p. 567-569. 8 refs. Translation.

Discussion of low-induction explosion-type generators designed to convert the energy of explosives into magnetic energy. The design and performance of both coaxial and two-busbar generators of this type are described. Line-drawings and current oscillograms are given. V.Z.

A68-15423 #

EFFECT OF THE MAGNETIC REYNOLDS NUMBER IN THE INDUCTION STRIATED-FLOW MHD GENERATOR.
J. Milewski (Polska Akademia Nauk, Instytut Maszyn Przepływowych, Gdańsk, Poland).
Académie Polonaise des Sciences, Bulletin, Série des Sciences Techniques, vol. 15, no. 9, 1967, p. 753-760.

Analysis of the effect of leakages of induced magnetic fields from the ferromagnetic core to the outside on the operation of a synchronous induction, striated-flow MHD generator. The striated flow of the working medium through the generator duct consists of alternate conducting and nonconducting sections. It is concluded that an effect of magnetic leakages does exist and its quantitative measure is the value of the magnetic Reynolds number R_m. The influence of the magnetic losses may be neglected in the case of a small R_m. In the case of a large R_m, some relative drop in the generator output may take place without any other disturbances. It is determined that from the practical viewpoint the effect of magnetic leakages may be disregarded. T.M.

A68-15642 #

EFFECTIVE CONDUCTIVITY IN A SEGMENTED-ELECTRODE MAGNETOHYDRODYNAMIC GENERATOR WITH ELEVATED ELECTRON TEMPERATURE.
S. Guha and Y. P. Singh (Indian Institute of Technology, Dept. of Physics, New Delhi, India).
British Journal of Applied Physics, vol. 18, Dec. 1967, p. 1819, 1820. Research supported by the Council of Scientific and Industrial Research of India.

Calculation of the effective conductivity in a segmented-electrode MHD generator under typical operating conditions. For this calculation, a power law is used for the dependence of the electron collision frequency on the electron velocity, together with expressions derived by Sodha (1965). M.F.

A68-16360 #

CONTRIBUTION TO THE STUDY OF END EFFECTS ON THE FLOW IN MHD GENERATORS [CONTRIBUTION A L'ETUDE DES EFFETS D'EXTREMITE SUR L'ECOULEMENT DANS LES GENERATEURS MAGNETOHYDRODYNAMIQUES].
L. Dragoş (Bucureşti, Universitatea, Bucharest, Rumania).
Revue Roumaine de Mathématiques Pures et Appliquées, vol. 12, no. 9, 1967, p. 1193-1205. 8 refs. In French.

Study of the plane flow of an electrically conducting fluid in an infinite nozzle with perfectly conducting and isolating walls under specified conditions. The flow takes place in the presence of an external magnetic field applied in the region of the electrodes, an orthogonal field in the plane of the flow. The mathematical problem is reduced to a system of two partial derivative equations of the second order, the distribution coefficients being known. Using two Green functions, an iterative procedure is given which makes it possible to determine all the approximations of the function of the current and electric potential. The exact solution of the problem is determined by an integral equation. M.F.

A68-16523 #

PULSE MHD GENERATOR WITH A SUPERCONDUCTING MAGNETIC SYSTEM [IMPUL'SNYI MAGNITOGIDRODINAMICHESKII GENERATOR SO SVERKHPROVODIASHCHEI MAGNITNOI SISTEMOI].
V. A. Kirillin, A. E. Sheindlin, E. I. Asinovskii, V. V. Sychev, V. B. Zenkevich, A. M. Maksimov, and V. A. Al'tov (Akademiia Nauk SSSR, Nauchno-Issledovatel'skii Institut Vysokikh Temperatur, Moscow, USSR).
Akademiia Nauk SSSR, Doklady, vol. 177, Nov. 1, 1967, p. 77-80. In Russian.

Experimental verification of the theory of a pulse MHD generator employing a superconducting magnetic system. The design and schematic diagram of the generator used in the experiments are described, and a graph showing the distribution of the magnetic inductance along the channel axis is given. Tests in which the magnetic system was disconnected from the generator supply sources and the supply of liquid helium in the cryostat was not replenished showed that the magnetic field intensity remained at a constant level. V.P.

A68-17540 * #

A REACTOR CONCEPT FOR SPACE POWER EMPLOYING THERMIONIC DIODES AND HEAT PIPES.
Colin A. Heath (NASA, Lewis Research Center, Cleveland, Ohio) and Edward Lantz (NASA, Lewis Research Center, Reactor Analysis Section, Cleveland, Ohio).
American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 6th, New York, N.Y., Jan. 22-24, 1968, Paper 68-122. 9 p. 18 refs.
Members, $1.00; nonmembers, $1.50.

Investigation of a thermionic generator power system using a reactor heat source connected to external diodes by heat pipes. A concept is proposed which appears capable of supplying up to several hundred kilowatts of electrical power. Experimental results from laboratory tests of both heat pipes and thermionic diodes have been used to set reasonable performance levels for thermionic diodes which are both heated and cooled by heat pipes. A reactor fueled with slab geometry fuel elements of uranium-233 nitride could provide a minimum power of 36 kwe limited by criticality considerations. Reactor control is effected by a combination of moderator and neutron absorbing material in a central region of the reactor. Neutronic calculations indicate that a 6% swing in reactivity is obtainable with this control system. Total mass of the reactor, thermionic diodes, radiator, and reactor shield for an instrumented payload is estimated to be 300 kg. (Author)

A68-17791
DIRECT ENERGY CONVERSION [ENERGIE DIREKTUMWANDLUNG].
Edited by K. J. Euler (Varta AG, Frankfurt am Main, West Germany).
Munich, Verlag Karl Thiemig KG (Thiemig-Taschenbücher. Volume 10), 1967. 371 p. In German.
$6.70.

CONTENTS:

A68-17792
TECHNICAL PROBLEMS OF DIRECT ENERGY CONVERSION [TECHNISCHE PROBLEME DER ENERGIE-DIREKTUMWANDLUNG].
Karl Joachim Euler (Varta AG, Frankfurt am Main, West Germany).
IN: DIRECT ENERGY CONVERSION [ENERGIE DIREKTUMWANDLUNG].
Edited by K. J. Euler.
Munich, Verlag Karl Thiemig KG (Thiemig-Taschenbücher. Volume 10), 1967, p. 1-25. In German.

Enumeration of the most important difficulties standing in the way of direct energy conversion. The various processes of direct energy conversion are discussed. These are: thermoelectric current generation, radionuclide batteries, thermionic converters, galvanic fuel cells, and MHD generators. A summary of the viewpoints of various authors is given. P.v.T.

A68-17793
PHOTOVOLTAIC ENERGY CONVERSION [PHOTOELEKTRISCHE ENERGIEUMWANDLUNG].
Hans Pfister (Siemens AG, Forschungslaboratorium, Erlangen, West Germany).
IN: DIRECT ENERGY CONVERSION [ENERGIE DIREKTUMWANDLUNG].
Edited by K. J. Euler.
Munich, Verlag Karl Thiemig KG (Thiemig-Taschenbücher. Volume 10), 1967, p. 26-61. 86 refs. In German.

Discussion of the efficiency of a p/n-junction photovoltaic cell for the conversion of monochromatic radiation and sunlight, mentioning the factors limiting the performance. A review of various solar cells is given, dealing especially with silicon cells and polycrystalline thin-film cells. The cells used for satellite-power supply have so far been exclusively of the silicon type, permitting efficiencies up to 12%. The life of these cells is normally limited by radiation damage, which is much lower for silicon n/p cells than for p/n cells. GaAs cells and polycrystalline thin-film cells possess a higher resistance to radiation damage than silicon cells. Although the efficiencies attained with thin-film cells are not as high as those of single-crystal cells, they have a more favorable power-to-weight ratio, and production costs are considerably lower. Reference is made to the anomalously high photovoltages observed in thin films, to the better utilization of the energy of the solar spectrum by cells with a p-n heterojunction and to the thermophotovoltaic converter for the direct conversion of thermal to electric energy. P.v.T.

A68-17797
ENERGY CONVERSION IN MAGNETOHYDRODYNAMIC (MHD) GENERATORS [ENERGIEWANDLUNG MIT MAGNETOHYDRODYNAMISCHEN (MHD-) GENERATOREN].
Thomas Bohn and Ernst A. Niekisch (EURATOM and Kernforschungsanlage, Institut für technische Physik, Julich, West Germany).
IN: DIRECT ENERGY CONVERSION [ENERGIE DIREKTUMWANDLUNG].
Edited by K. J. Euler.
Munich, Verlag Karl Thiemig KG (Thiemig-Taschenbücher. Volume 10), 1967, p. 221-267. 58 refs. In German.

Outline of the basic principles of magnetohydrodynamic power generation. The electric conductivity of MHDs is caused by the thermal ionization of alkali-seeded flame exhausts or noble gases. An endeavor is being made to increase the conductivity of MHDs. The instabilities of electrothermal, electroacoustic, and mixed-type MHDs are investigated. It is found that energy can be extracted from the working fluid by braking the electromagnetic forces. Many problems still remain unsolved, such as difficulties in the field of high-temperature walls, electrodes, and insulation material. Other problems must be faced in the design of air preheaters and in the development of large magnets. P.v.T.

A68-17827
MULTI-FUEL 100 WATT TE GENERATOR.
Andrew Herchakowski (U.S. Army, Electronics Command, Fort Monmouth, N.J.).
IN: U.S. ARMY, ELECTRONICS COMMAND, ANNUAL POWER SOURCES CONFERENCE, 21ST, ATLANTIC CITY, N.J., MAY 16-18, 1967, PROCEEDINGS.
Red Bank, N.J., PSC Publications Committee, 1967. 5 p.

Determination of the feasibility of mating an ultrasonic atomizing burner, developed by the Battelle Memorial Institute (BMI), with the RCA SiGe thermoelectric converter. The progress of this program is reported, together with results of tests made on a 100-watt exploratory model for both atomizer and vaporized burner systems for comparison. The work accomplished during this program demonstrates the feasibility of combining the BMI atomizing type burner with the RCA SiGe converter into a workable fossil-fuel-fired thermoelectric generator system. The BMI burner brings with it the features of multifuel use, simplified construction, reduced size and weight, increased ruggedness, the capabilities of simplified and practical field operation, increased mantle life, and improved performance reliability. P.v.T.

A68-18285 #
PLASMA STABILITY AND VOLTAGE FLUCTUATIONS IN AN MHD GENERATOR [USTOICHIVOST' PLAZMY I KOLEBANIIA NAPRIAZHENIIA MGD-GENERATORA].
R. V. Ganefel'd and E. P. Strashinin.
Magnitnaia Gidrodinamika, no. 4, 1967, p. 33-36. 8 refs. In Russian.

Discussion of the stability of the isothermal equilibrium plasma of an MHD generator in the presence of potential and nonpotential perturbation waves in the ionized component of the working body. It is shown that strong electromagnetic and/or acoustic waves, which do not drift with the plasma flux, may produce a voltage modulation in MHD generators. The modulation frequencies determined theoretically are in good agreement with observations.
V.Z.

A68-18450 #

CALCULATION OF MAGNETOHYDRODYNAMIC FLOWS AND THE PROBLEM OF OBTAINING AN OPTIMAL MHD GENERATOR [K RASCHETU MAGNITOGIDRODINAMICHESKIKH TECHENII I ZADACHA OTYSKANIIA OPTIMAL'NOGO MGD-GENERATORA].
N. I. Kolosnitsyn and K. P. Staniukovich (Vsesoiuznyi Nauchno-Issledovatel'skii Institut Elektromekhaniki, Moscow, USSR).
Teplofizika Vysokikh Temperatur, vol. 5, Nov.-Dec. 1967, p. 1087-1093. In Russian.

Application of a quasi-one-dimensional approximation of magnetohydrodynamic flow to the calculation of magnetohydrodynamic flow in a channel and to the problem of achieving the optimum regime of power generation in an MHD generator. The problem of determining the optimal conditions of power generation is reduced to obtaining a certain optimal function of the magnetic field and to finding the optimal boundary conditions when that function is known. Specifically the optimization of an MHD generator is analyzed by determining an optimal function of the magnetic field which will ensure the maximum power functional for a given generator length, or, conversely, the minimum generator length for a given power functional.
T.M.

A68-19482

PLASMA HEATING BY THE FAST HYDROMAGNETIC WAVE.
K. Chung and M. A. Rothman (Princeton University, Plasma Physics Laboratory, Princeton, N.J.).
Physics of Fluids, vol. 10, Dec. 1967, p. 2634-2641. 16 refs.
AEC Contract No. AT (30-1)-1238; NSF Grant No. GP-579.

The fast (right-handed)hydromagnetic wave is generated by a Stix coil installed on the Model C stellarator. Maximum wave generation and heating occurs, as expected, under conditions such that the wavelength of the propagating wave equals the wavelength of the coil structure. Measurements of diamagnetic pressure determine the efficiency for conversion of rf power into thermal energy. Theoretical calculations of heating rates show that plasma resistivity and Landau damping are insufficient to account for the observed heating rates if only the body wave is considered. Introduction of surface waves associated with finite electron mass results in increased E_z fields which enhance the heating rate. (Author)

A68-19561 #

SELECTION OF THE FLOW REGIME IN AN MHD GENERATOR WITH SERIES-CONNECTED ELECTRODES [K VOPROSU O VYBORE REZHIMA TECHENIIA V MGD-GENERATORE S POSLEDOVATEL'NYM SOEDINENIEM ELEKTRODOV].
A. I. El'kin and E. I. Iantovskii.
Akademiia Nauk SSSR, Izvestiia, Energetika i Transport, Nov.-Dec. 1967, p. 107-113. 5 refs. In Russian.

Analysis, in a quasi-one-dimensional approximation, of the flow of plasma in an MHD channel with series-connected segmented electrodes - i.e., with a fixed direction of the electric field and the absence of a longitudinal current. The flow regime is examined for the cases of constant Mach number, constant temperature, and constant electrical efficiency. The possibility of efficient energy conversion is demonstrated for an MHD generator with a single electrical load. For multiatomic gases, a supersonic flow regime is recommended with a variable angle of inclination of the equipotentials such that there is no longitudinal current in the gas and the local electrical efficiency is constant.
T.M.

A68-19791 *

PROGRESS IN AIRCRAFT GAS TURBINE ENGINE DEVELOPMENT.
Abe Silverstein (NASA, Lewis Research Center, Cleveland, Ohio).
(International Council of the Aeronautical Sciences, Congress, 5th, London, England, Sept. 12-16, 1966.)
IN: AEROSPACE PROCEEDINGS 1966; ROYAL AERONAUTICAL SOCIETY, CENTENARY CONGRESS AND INTERNATIONAL COUNCIL OF THE AERONAUTICAL SCIENCES, CONGRESS, 5TH, LONDON, ENGLAND, SEPTEMBER 12-16, 1966. VOLUME 2.

Edited by Joan Bradbrooke, Joan Bruce, and R. R. Dexter. London, Macmillan and Co., Ltd., 1967, p. 587-604; Discussion, A. C. Ackerman (Ackerman Consultants, Canoga Park, Calif.), p. 604, 605. 5 refs.

Discussion of current research and development efforts on materials and cooling of aircraft gas-turbine engines. The better cast nickel-based alloys now available allow turbine-inlet temperatures as high as 1800°F without any assistance from cooling and tantalum alloys with oxidation-resistant coatings as high as 2400°F. Inlet-engine matching problems and engine-cooling studies offer the possibility of much higher turbine-inlet temperatures than are now used, when properly applied. The use of liquid methane as a turbine engine fuel offers interesting possibilities because of its higher heating value, greater cooling capacity, and lower current price per pound. Prospects for reducing the noise associated with fan-jet powered aircraft are also encouraging.
W.A.E.

A68-19849 * #

PERFORMANCE CHARACTERISTICS OF A SINGLE-WAVELENGTH LIQUID-METAL MHD INDUCTION GENERATOR WITH END-LOSS COMPENSATION.
Donald J. Cerini and David G. Elliott (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.).
AIAA Journal, vol. 6, Mar. 1968, p. 503-510. 13 refs.

Experiments were performed on a 1000-watt, 700-Hz, constant-velocity, ac MHD induction generator using room-temperature sodium-potassium alloy (NaK) as the working fluid. The purpose of the experiments was to determine the electrical losses and power production in the fluid with a winding of the type expected to provide maximum efficiency in the short generators required for low friction loss in liquid-metal MHD power systems. The winding produced a single-wavelength traveling field together with oscillating compensating fields at each end of the generator to cancel the voltage induced between the conducting side plates by the termination of the traveling field. The efficiency of power generation in the fluid reached 0.54 at a slip s of 0.55, compared with the ideal efficiency $(1 + s)^{-1} = 0.65$ of an infinite-length generator. The compensating fields canceled the side-plate voltage and reduced the electrical end losses in the fluid by a factor of 7. (Author)

A68-19914

DETERMINATION OF THE STABILIZATION TIME OF THE NON-EQUILIBRIUM STATE AT THE ENTRANCE TO A MHD-GENERATOR CHANNEL.
V. A. Bitiurin and P. P. Ivanov (Akademiia Nauk SSSR, Nauchno-Issledovatel'skii Institut Vysokikh Temperatur, Moscow, USSR).
(Teplofizika Vysokikh Temperatur, vol. 5, May-June 1967, p. 418-422.)
High Temperature, vol. 5, May-June 1967, p. 376-379. 9 refs. Translation.

Analysis of the buildup process of a nonequilibrium ionization of an argon plasma with cesium additions under conditions corresponding to a plasma flowing into an MHD channel. The time required for the buildup of this process is determined from the solutions of the energy and balance equations of the number of particles (for electrons).
V.P.

A68-20175 *

LARGE SUPERCONDUCTING MAGNETS FOR M.H.D.
Z. J. J. Stekly (Avco Corp., Avco-Everett Research Laboratory, Everett, Mass.).
IN: CRYOGENIC ENGINEERING: PRESENT STATUS AND FUTURE DEVELOPMENT; CRYOGENIC ASSOCIATION OF JAPAN, INTERNATIONAL CRYOGENIC ENGINEERING CONFERENCE, 1ST, TOKYO AND KYOTO, JAPAN, APRIL 9-13, 1967, PROCEEDINGS.

Conference sponsored by the Cryogenic Association of Japan and the Tokyo Electric Power Co.

London, Heywood-Temple Industrial Publications, Ltd., 1968, p. 112-118. 10 refs.
Research supported by Avco Corp. and NASA.
Brief review of the criteria required for stable superconducting magnets and an examination of the present state of the art in MHD type superconducting magnets. A discussion of the problems and the degree of scale-up required from the present state of the art in MHD type superconducting magnets is given. The problems of steady-state refrigeration requirements, margin of stable operation and emergency system shutdown are treated. M.G.

A68-20399
MAGNETOHYDRODYNAMIC COUPLING USING A LIQUID METAL FLYWHEEL.
L. K. Martinson.
(Magnitnaia Gidrodinamika, vol. 1, Oct.-Dec. 1965, p. 85-90.)
Magnetohydrodynamics, vol. 1, Oct.-Dec. 1965, p. 54-57. 8 refs.
Translation.
Description of a scheme for a coupling with a liquid-metal flywheel rotating under the action of crossed electric and magnetic fields. The steady-state problem of the motion of a conducting fluid in an axial magnetic field in a channel with rotating cylindrical electrodes is solved with allowance for the effect of the nonconducting end plates. M.F.

A68-20403
LIQUID-METAL MAGNETOHYDRODYNAMIC GENERATORS AT LARGE MAGNETIC REYNOLDS NUMBERS.
Iu. M. Mikhailov.
(Magnitnaia Gidrodinamika, vol. 1, Oct.-Dec. 1965, p. 113-119.)
Magnetohydrodynamics, vol. 1, Oct.-Dec. 1965, p. 72-75.
Translation.
The induction equation is solved in the region of large magnetic Reynolds numbers for flat and cylindrical channels with a working section of finite length. The fluid velocity field is assumed given. The magnetic field distribution depends both on the magnetic Reynolds number and on the geometry of the working section. (Author)

A68-20598
STATUS OF CONTROLLED THERMONUCLEAR RESEARCH.
C. M. Van Atta (California, University, Lawrence Radiation Laboratory, Berkeley, Calif.).
IN: ADVANCED PROPULSION CONCEPTS; PROCEEDINGS OF THE FOURTH SYMPOSIUM, PALO ALTO, CALIF., APRIL 26-28, 1965.
Symposium sponsored by the Office of Scientific Research of the U.S. Air Force and the United Aircraft Corp.
New York, Gordon and Breach, Science Publishers, Inc., 1966, p. 257-278.
AEC-sponsored research.
General discussion of the current theoretical understanding, experimental achievement, and technological accomplishments in the study of controlled nuclear fusion. The areas treated are: (1) the difficulties involved in carrying out relevant experiments with diagnostic results which are relatively free of ambiguity, (2) the theoretical understanding of the stability of real plasmas, taking into account the finite orbit sizes of the particles, the finite resistivity of the plasma, and many other elements of realism, (3) the realization of application of minimum-B configurations in suppressing gross hydromagnetic instabilities in magnetic mirror confinement, and (4) the achievement of a stable and rigid E-layer, even though still weak (1%) as compared with that required for field reversal. A brief description and discussion of the work at the Astron experimental facility is given. M.G.

A68-20734
CHEMICAL ENERGY ENGINES.
A. G. Hammitt (TRW Systems Group, Redondo Beach, Calif.).
Advanced Energy Conversion, vol. 7, Feb. 1968, p. 191-200. 5 refs.
Examination of the relations governing the conversion of chemical energy to mechanical or electrical energy. The free-energy change of the chemical reaction limits the upper temperature at which heat can be supplied to a heat engine. It is pointed out that the use of a heat engine in a power conversion system does not degrade the performance unless it sets a limit on the maximum temperatures below that imposed by the chemical reaction. R.B.S

A68-20829 #
THE EFFECT OF THE BULK GAS ON THE ELECTRICAL CONDUCTIVITY OF POTASSIUM-SEEDED NON-EQUILIBRIUM PLASMAS.
H. I. Ellington (Robert Gordon's Technical College, Aberdeen, Scotland).
Journal of Physics, Part D - British Journal of Applied Physics, vol. 1, Feb. 1968, p. 189-192.
Discussion of recently published experimental results of Ellington and Ralph (1966), showing the effect of the diluent gas on the electrical properties of alkali-metal-seeded rare-gas plasmas in terms of an extension of the two-temperature conductivity theory first proposed by Kerrebrock (1962). The theory developed is used to give an estimate, based on experiment, of the effect on K-He, K-Ne and K-Ar plasmas of varying the diluent pressure from 0.01 to 20 atm. It is concluded that argon and neon seeded with potassium (or cesium) appear to be suitable for use as the working fluid in an MHD generator operating at pressures up to 10 or 20 atm, but that helium appears to be unsuitable as a diluent at pressures above 2 or 3 atm. M.F.

A68-22530
THERMODYNAMICS OF MHD ENERGY CONVERSION.
Harold M. DeGroff (Purdue University, School of Aeronautical and Engineering Sciences, Lafayette, Ind.) and Richard F. Hoglund (Purdue University, Aerospace Sciences Laboratory, Lafayette, Ind.).
IN: COMBUSTION AND PROPULSION; AGARD COLLOQUIUM ON ENERGY SOURCES AND ENERGY CONVERSION, 6TH, CANNES, FRANCE, MARCH 16-20, 1964, PAPERS.
Research sponsored by the Combustion and Propulsion Panel of NATO-AGARD.
Edited by H. M. DeGroff, R. F. Hoglund, J. Fabri, T. F. Nagey, and R. E. Rumbaugh, Jr.
New York, Gordon and Breach, Science Publishers, Inc. (AGARDograph 81), 1967, p. 419-472; Discussion, Helmut Burkhart and Ralph Roberts (U.S. Navy, Office of Naval Research, Washington, D.C.), p. 472-475. 69 refs.
Assessment of the accuracy to which the performance of MHD energy conversion devices can be predicted. Both open-cycle and closed-cycle linear MHD generators are discussed. The recent progress made in open-cycle generators, with combustion reactions serving as the heat source, is described. Equilibrium thermodynamics is used to determine the theoretical performance of these generators. Particular attention is given to the loss mechanisms at the edges of field regions and through the wall and electrode boundary layers. Existing experimental results are compared with the theoretical predictions. Major engineering problems are pointed out and discussed. P.v.T.

A68-22531
NON-EQUILIBRIUM MODES OF MHD CONVERTERS.
Ian Fells (Newcastle-upon-Tyne, University, Dept. of Chemical Engineering, Newcastle-upon-Tyne, England).
IN: COMBUSTION AND PROPULSION; AGARD COLLOQUIUM ON ENERGY SOURCES AND ENERGY CONVERSION, 6TH, CANNES, FRANCE, MARCH 16-20, 1964, PAPERS.
Research sponsored by the Combustion and Propulsion Panel of NATO-AGARD.
Edited by H. M. DeGroff, R. F. Hoglund, J. Fabri, T. F. Nagey, and R. E. Rumbaugh, Jr.
New York, Gordon and Breach, Science Publishers, Inc. (AGARDograph 81), 1967, p. 477-499; Discussion, J. M. Jenkins (Martech Consultants, Ltd.) and G. Klein (Compagnie Générale d'Electricité de Paris, Centre de Recherches, Marcoussis, Essonne, France), p. 499, 500. 23 refs. Discussion in English and French.
Discussion of various approaches to problems of MHD electric-power generation, with reference to nonequilibrium modes. The reaction zones of hydrocarbon flames exhibit a marked departure from equilibrium and, associated with this, ionization levels one

million times greater than the predicted equilibrium levels. Phased combustion aimed at promoting this effect can lead to systems in which seed material is unnecessary. Oscillating combustion systems operating at both low and high frequencies lead to periodic high ionization levels with a low time-averaged temperature. Combustion-driven detonations can be maintained in various modes; the spinning mode seems particularly useful for MHD power generation. In addition to lowering the time-averaged temperature, the operation of pulsed systems makes possible the generation of alternating rather than direct current. The freezing of equilibrium during expansion can lead to high conductivity at lower temperatures; such an effect is applicable to closed as well as open cycle systems. F.R.L.

A68-22534
POTENTIALITIES OF DIRECT ELECTRO-FLUID DYNAMIC ENERGY CONVERSION PROCESSES FOR POWER GENERATION.
Hans Von Ohain and Frank Wattendorf.
IN: COMBUSTION AND PROPULSION; AGARD COLLOQUIUM ON ENERGY SOURCES AND ENERGY CONVERSION, 6TH, CANNES, FRANCE, MARCH 16-20, 1964, PAPERS.
Research sponsored by the Combustion and Propulsion Panel of NATO-AGARD.
Edited by H. M. DeGroff, R. F. Hoglund, J. Fabri, T. F. Nagey, and R. E. Rumbaugh, Jr.
New York, Gordon and Breach, Science Publishers, Inc. (AGARDograph 81), 1967, p. 541-561. 11 refs.

Discussion of current research on electrofluid dynamics (EFD) conversion, whereby the fluid dynamic energy of a working medium containing ions or charged colloids is transformed into electrical energy by passing through an electrostatic field. EFD processes are characterized by low current density and high voltage. While the power density is lower than that indicated for magnetofluid dynamics, the power-to-weight ratio may still prove favorable, due to the lack of need for heavy magnetic equipment. A review is given of recent studies of the fundamental relationships between aerothermodynamic and electrical performance characteristics, including the effects of physicochemical properties of the working medium, basic configurations of electrodes and the conversion section, and scaling and similarity laws. M.G.

A68-22535
PERFORMANCE CHARACTERISTICS OF ELECTRO-FLUID DYNAMIC ENERGY CONVERSION PROCESSES EMPLOYING VISCOUS COUPLING.
Maurice O. Lawson.
IN: COMBUSTION AND PROPULSION; AGARD COLLOQUIUM ON ENERGY SOURCES AND ENERGY CONVERSION, 6TH, CANNES, FRANCE, MARCH 16-20, 1964, PAPERS.
Research sponsored by the Combustion and Propulsion Panel of NATO-AGARD.
Edited by H. M. DeGroff, R. F. Hoglund, J. Fabri, T. F. Nagey, and R. E. Rumbaugh, Jr.
New York, Gordon and Breach, Science Publishers, Inc. (AGARDograph 81), 1967, p. 563-580.

Determination of the performance characteristics of electrofluiddynamic energy conversion processes employing viscous coupling between the neutral molecules and the electrically charged particles. The convergence efficiency and other electrofluiddynamic performances values (including the effects of the physical properties of the working medium, the influence of geometric parameters, and scaling) are studied. Very favorable power densities and stage efficiencies can be obtained with viscous-coupled electrofluiddynamic energy conversion processes where electrodes and channel configurations have low aerodynamic losses and where pressurized working gases, having the particular properties of low molecular weight and high dielectric strength, are utilized. M.G.

A68-22536
PERFORMANCE CHARACTERISTICS OF ELECTRO-BALLISTIC GENERATORS.
Siegfried Hasinger.
IN: COMBUSTION AND PROPULSION; AGARD COLLOQUIUM ON ENERGY SOURCES AND ENERGY CONVERSION, 6TH, CANNES, FRANCE, MARCH 16-20, 1964, PAPERS.
Research sponsored by the Combustion and Propulsion Panel of NATO-AGARD.
Edited by H. M. DeGroff, R. F. Hoglund, J. Fabri, T. F. Nagey, and R. E. Rumbaugh, Jr.
New York, Gordon and Breach, Science Publishers, Inc. (AGARDograph 81), 1967, p. 581-601. 8 refs.

Discussion of the ballistic principle for the direct conversion of fluid dynamic energy into electric energy by using a gas flow to transport electric charges to a high electrical potential. In this case, the particles are first accelerated, and then their kinetic energy is used to carry the charges against the electric field. Ballistic generator performance is discussed, including characteristic voltage regime, particle velocity, charge-to-mass ratio, conversion length, elastic power concentration, dynamic pressure, and mass density of the particle flow. For a detailed numerical evaluation of ballistic generators, the basic equations are combined into one diagram by forming appropriate parameters. The principal magnitudes in these parameters - i.e., voltage, current density, conversion length, power density, entrance field strength, or mass density of the particle flow are discussed. A more exact electric-field distribution in the conversion region of a ballistic generator for the case of plane-parallel electrodes (no radial field lines) is derived. The ballistic generator with radial electric field is also treated. M.G.

A68-22537
ION GENERATION BY CORONA DISCHARGE FOR ELECTRO-FLUID ENERGY CONVERSION PROCESSES.
Maurice O. Lawson.
IN: COMBUSTION AND PROPULSION; AGARD COLLOQUIUM ON ENERGY SOURCES AND ENERGY CONVERSION, 6TH, CANNES, FRANCE, MARCH 16-20, 1964, PAPERS.
Research sponsored by the Combustion and Propulsion Panel of NATO-AGARD.
Edited by H. M. DeGroff, R. F. Hoglund, J. Fabri, T. F. Nagey, and R. E. Rumbaugh, Jr.
New York, Gordon and Breach, Science Publishers, Inc. (AGARDograph 81), 1967, p. 603-612.

Investigation of the generation of unipolar ions or charged colloids in high-speed gaseous working media used in electrofluiddynamic energy conversion processes. Corona discharge configurations enabling simultaneous employment of more than one working medium - i.e., vapor and gas for the formation of charged colloids - are presented. It is shown that current values produced in a high-speed flow by the corona phenomena are dependent on the gas speed and physical properties of the gas or working medium. Scaling considerations show that the amount of current produced varies linearly with both the pressure and also the diameter of the electrode configuration, rather than the square of the diameter. It is demonstrated that numerical solutions based on simplifying assumptions can properly predict the order of magnitude of ion current production as well as colloid current production. M.G.

A68-22538
EXPERIMENTAL TECHNIQUES IN ELECTRO-FLUID DYNAMIC ENERGY CONVERSION RESEARCH.
Michael Hawes.
IN: COMBUSTION AND PROPULSION; AGARD COLLOQUIUM ON ENERGY SOURCES AND ENERGY CONVERSION, 6TH, CANNES, FRANCE, MARCH 16-20, 1964, PAPERS.
Research sponsored by the Combustion and Propulsion Panel of NATO-AGARD.
Edited by H. M. DeGroff, R. F. Hoglund, J. Fabri, T. F. Nagey, and R. E. Rumbaugh, Jr.
New York, Gordon and Breach, Science Publishers, Inc. (AGARDograph 81), 1967, p. 613-629; Discussion, E. Knoernschild (Deutsche Versuchsanstalt für Luft- und Raumfahrt, Porz-Wahn, West Germany), p. 629, 630.

Discussion of experimental equipment and testing methods for electro-fluid dynamic power generation. Closed-cycle or simulated closed-cycle operation is treated. Included are investigations of fluid-dynamic energy transfer from a supersonic jet of high molec-

ular weight to a recirculating gas of low molecular weight, the mass flow of the supersonic jet being small in comparison to that of the recirculating gas. Methods of generation of ions or charged colloids of one polarity employing corona discharge are discussed. The effects of the geometric configuration of the conversion section are considered, as well as the problem of the scaling characteristics. The effects of variation in pressure in the conversion section are noted and the equipment and instrumentation for high-voltage, low-current, power measurements are described. The theoretical results of the analysis presented indicate that a power density of 750 watts/cm^2 can be obtained. In an attempt to improve the overall effect of the process, two-loop operation is suggested, energy transfer being accomplished with the aid of mixing by means of ejectors. M.G.

A68-22539
THERMODYNAMICS OF THERMOELECTRIC CONVERSION.
V. Ferro (Torino, Politecnico, Turin, Italy).
IN: COMBUSTION AND PROPULSION; AGARD COLLOQUIUM ON ENERGY SOURCES AND ENERGY CONVERSION, 6TH, CANNES, FRANCE, MARCH 16-20, 1964, PAPERS.
Research sponsored by the Combustion and Propulsion Panel of NATO-AGARD.
Edited by H. M. DeGroff, R. F. Hoglund, J. Fabri, T. F. Nagey, and R. E. Rumbaugh, Jr.
New York, Gordon and Breach, Science Publishers, Inc. (AGARDograph 81), 1967, p. 633-649. 12 refs.

Study of experimental thermoelectric phenomena and their interpretation and correlation, according to the thermodynamic theory of irreversible processes. The case of an ideal thermoelectric generator operating at optimum efficiency or at maximum electric power output conditions is investigated. The Thomson and Peltier effects are also considered. B. B.

A68-22540
HIGH-TEMPERATURE THERMOELECTRIC MATERIAL LIMITATIONS.
C. M. Kelley and G. C. Szego.
IN: COMBUSTION AND PROPULSION; AGARD COLLOQUIUM ON ENERGY SOURCES AND ENERGY CONVERSION, 6TH, CANNES, FRANCE, MARCH 16-20, 1964, PAPERS.
Research sponsored by the Combustion and Propulsion Panel of NATO-AGARD.
Edited by H. M. DeGroff, R. F. Hoglund, J. Fabri, T. F. Nagey, and R. E. Rumbaugh, Jr.
New York, Gordon and Breach, Science Publishers, Inc. (AGARDograph 81), 1967, p. 651-676; Discussion, Simon Thomas, p. 676, 677. 11 refs.

Determination of the limits set by materials properties to the application of thermoelectric energy conversion. It is found that melting points and vapor decomposition pressure begin to restrict the choice of materials just below 2000°K. This restriction becomes continually more severe through the next 1000°K. Solubility of contact materials does not set any specific limit, but it makes the use of volatile or liquid encapsulated material unlikely at the highest temperatures proposed. B. B.

A68-22541
FUEL CELL REACTANT PROPERTIES.
R. G. H. Watson (Ministry of Defence, Royal Naval Scientific Service, Admiralty Materials Laboratory, Dorset, England).
IN: COMBUSTION AND PROPULSION; AGARD COLLOQUIUM ON ENERGY SOURCES AND ENERGY CONVERSION, 6TH, CANNES, FRANCE, MARCH 16-20, 1964, PAPERS.
Research sponsored by the Combustion and Propulsion Panel of NATO-AGARD.
Edited by H. M. DeGroff, R. F. Hoglund, J. Fabri, T. F. Nagey, and R. E. Rumbaugh, Jr.
New York, Gordon and Breach, Science Publishers, Inc. (AGARDograph 81), 1967, p. 681-706; Discussion, K. R. Williams (Shell Research, Ltd., Thornton Research Centre, Chester, England), p. 706, 707. 54 refs.

The fuel cell is considered as a chemical energy converter, and the components which contribute to its important dimensions are discussed. The performance of the fuel cell system is related to the properties of its reacting components and the contribution they make to the various sources of energy loss. The values of some of these properties are readily accessible, such as the density and energy content of a fuel, which help to determine the maximum specific energy content of a fuel cell system. Other properties, which related to energy losses, and determine cell efficiency from which the actual specific energy content is determined, may be a function of a particular cell design. For instance the amount of polarization due to slow fuel electrode reaction will involve a wide range of properties including those of electrode and fuel materials, at the cell conditions used. The reactant properties that are useful in fuel cell system design are derived in this discussion and concern the fuel, oxidant and exhaust products, and the electrodes and electrolyte. Appropriate values are tabulated and used to illustrate factors in cell design. Areas of apparent ignorance are discussed in relation to the need for further work. (Author)

A68-22545 *
THERMODYNAMICS AND APPLICATIONS OF BIOELECTROCHEMICAL ENERGY CONVERSION SYSTEMS.
Michael G. Del Duca and John M. Fuscoe (NASA, Office of Advanced Research and Technology, Biotechnology and Human Research, Washington, D.C.).
IN: COMBUSTION AND PROPULSION; AGARD COLLOQUIUM ON ENERGY SOURCES AND ENERGY CONVERSION, 6TH, CANNES, FRANCE, MARCH 16-20, 1964, PAPERS.
Research sponsored by the Combustion and Propulsion Panel of NATO-AGARD.
Edited by H. M. DeGroff, R. F. Hoglund, J. Fabri, T. F. Nagey, and R. E. Rumbaugh, Jr.
New York, Gordon and Breach, Science Publishers, Inc. (AGARDograph 81), 1967, p. 811-838; Discussion, E. M. Cohn, p. 838, 839.

Consideration of applications of the results of biochemical research and development to bioelectrochemical energy conversion (the process of converting the chemical free energy of biologically catalyzed reactions to electrical energy). Current progress is reviewed. A synopsis is given of suggested applications, ranging from the use of bioelectric currents to identify toxic materials, and to power cardiac pacemakers implanted in the human heart, to the generation of electric power in remote areas of the world. F. R. L.

A68-22547
PHOTOVOLTAIC CELLS WITH CONCENTRATORS [CELLULES PHOTOVOLTAIQUES AVEC CONCENTRATEURS].
Pierre Leclerc (Compagnie Générale de Télégraphie Sans Fil, Centre de Recherches Physico-Chimiques, Puteaux, France).
IN: COMBUSTION AND PROPULSION; AGARD COLLOQUIUM ON ENERGY SOURCES AND ENERGY CONVERSION, 6TH, CANNES, FRANCE, MARCH 16-20, 1964, PAPERS.
Research sponsored by the Combustion and Propulsion Panel of NATO-AGARD.
Edited by H. M. DeGroff, R. F. Hoglund, J. Fabri, T. F. Nagey, and R. E. Rumbaugh, Jr.
New York, Gordon and Breach, Science Publishers, Inc. (AGARDograph 81), 1967, p. 863-871. In French.

Study of the influence of the development and operational parameters of a photodiode on its efficiency in a photovoltaic generator. The influence of the series resistance on the efficiency of the generator was investigated. Studies were also made of means of improving the performance of these cells. F. R. L.

A68-22548
DEVELOPMENT OF A THERMOPHOTOVOLTAIC CONVERTER [REALISATION D'UN CONVERTISSEUR THERMOPHOTOVOLTAIQUE].
A. Fortini, Ph. Bauduin, and P. Sibillot (Laboratoire Central des Industries Electriques, Fontenay-aux-Roses, Hauts-de-Seine, France).
IN: COMBUSTION AND PROPULSION; AGARD COLLOQUIUM ON ENERGY SOURCES AND ENERGY CONVERSION, 6TH, CANNES, FRANCE, MARCH 16-20, 1964, PAPERS.
Research sponsored by the Combustion and Propulsion Panel of NATO-AGARD.
Edited by H. M. DeGroff, R. F. Hoglund, J. Fabri, T. F. Nagey, and R. E. Rumbaugh, Jr.

New York, Gordon and Breach, Science Publishers, Inc. (AGARDograph 81), 1967, p. 873-896. 14 refs. In French.

Theoretical analysis of the influence of the geometrical and electrical parameters defining a photovoltaic cell with reference to the efficiency of conversion of luminous energy into electric power. The basic theory is briefly reviewed. The spectral adaptation of the cell is studied. Theoretical predictions and experimental data are compared. It is shown to be possible to develop a thermophotovoltaic converter of very acceptable efficiency, of the order of 15%. F. R. L.

A68-22549

P-I-N STRUCTURES FOR CONTROLLED SPECTRUM PHOTOVOLTAIC CONVERTERS.

David C. White (Massachusetts Institute of Technology, Cambridge, Mass.) and Richard J. Schwartz (Energy Conversion, Inc., Cambridge, Mass.).

IN: COMBUSTION AND PROPULSION; AGARD COLLOQUIUM ON ENERGY SOURCES AND ENERGY CONVERSION, 6TH, CANNES, FRANCE, MARCH 16-20, 1964, PAPERS.

Research sponsored by the Combustion and Propulsion Panel of NATO-AGARD.

Edited by H. M. DeGroff, R. F. Hoglund, J. Fabri, T. F. Nagey, and R. E. Rumbaugh, Jr.

New York, Gordon and Breach, Science Publishers, Inc. (AGARDograph 81), 1967, p. 897-921; Discussion, Emil Kittl (U.S. Army, Electronics Command, Electronic Components Laboratory, Fort Monmouth, N.J.), p. 921, 922. 23 refs.

Review of the present status of thermophotovoltaic (TPV) research, with investigation of the advantages of p-i-n photovoltaic structures for use with high-intensity controlled spectrum sources, to establish the important characteristics of such devices in a TPV system. An edge-irradiated p-i-n structure is analyzed, and marked advantages are found because of higher output voltages, reduced series resistance, and improved collection efficiencies. This type of structure also possesses potential advantages for the conversion of high-energy particles to electrical energy. F.R.L.

A68-22803

STUDY OF THE END EFFECTS AND THE EFFECT OF THE INDUCED MAGNETIC FIELD IN AN MHD GENERATOR [ETUDE DES EFFETS D'EXTREMITE ET DU CHAMP MAGNETIQUE INDUIT, DANS UN GENERATEUR MHD].

L. Dragoş (Bucureşti, Universitatea, Bucharest, Rumania).

International Journal of Engineering Science, vol. 5, Dec. 1967, p. 919-938. 19 refs. In French.

Study of the expansion to infinity of an electrically conducting fluid in a tube of constant rectangular cross section having two of the electrodes applied in the region $x \geqslant 0$ of the horizontal walls and the vertical isolating walls. The flow takes place in the presence of an external magnetic field applied only in the electrode region. The mathematical problem, presented in the terms of the distributions, contains two parameters R_M and $\lambda = R_M R_H$. By using three Green's functions, an iterative process is developed from which all the approximations of the functions of current, electric potential, and magnetic field can be determined. M. F.

A68-22960 #

RECENT DEVELOPMENTS IN CLOSED-CYCLE PLASMA MHD SYSTEMS.

William D. Jackson (Illinois, University, Chicago, Ill.).

Power Reactor Technology and Reactor Fuel Processing, vol. 10, Spring 1967, p. 136-147. 99 refs.

Discussion of the current status, recent developments, and prospects of the closed-cycle plasma MHD system. The difficulty of attaining nonequilibrium ionization is pointed out. Recent developments in nonequilibrium theory and measurements, conformal mapping and electrode leakage, flow and nonequilibrium ionization, and closed-cycle experiments are described. The cycle performance and preliminary economics of closed-cycle plasma MHD systems are discussed, the prospects for closed-cycle plasma MHD systems are analyzed, and the reactor requirements and the possibilities of attaining them are reviewed. M. F.

A68-23120 #

EXPERIMENTAL STUDY OF NONEQUILIBRIUM IONIZATION IN A LINEAR MHD GENERATOR.

Bert Zauderer (General Electric Co., Missile and Space Div., Space Sciences Laboratory, King of Prussia, Pa.).

AIAA Journal, vol. 6, Apr. 1968, p. 701-707. 26 refs.

Results of a study to obtain, through magnetically induced ionization, a plasma in which the electron temperature was significantly greater than the gas stagnation temperature. The MHD generator was mounted at the downstream end of a shock tube. Noble gases were shock-heated to static gas temperatures, corresponding to equilibrium electron densities n_e between 10^8 cm^{-3} and 10^{12} cm^{-3}. Results showed that an initial n_e of the order of 10^{11} cm^{-3} was required at the generator entrance to obtain significant magnetically induced ionization; if n_e was produced by preionization with an applied electric field, the preionization power requirement was 10% of the maximum generator power output. Electrode conduction losses controlled the minimum initial n_e requirement, the ionization growth rate in the generator, and the maximum generator power output. The rate of ionization growth in the freestream of the generator was in agreement with the predictions of a one-dimensional theory in which electron collisional ionization and recombination dominated the rate equations. The measured steady-state, electron densities in the generator were up to 1000 times greater than the corresponding values at the gas stagnation temperatures. The measurements were in general agreement with the theoretical predictions obtained from the electron energy equation and the Saha equation at the electron temperature. (Author)

A68-23796

ONE-DIMENSIONAL FLOW OF A PLASMA IN A MHD ENERGY CONVERTER CHANNEL.

L. A. Vulis and M. K. Kusainov.

(Teplofizika Vysokikh Temperatur, vol. 5, July-Aug. 1967, p. 663-675.)

High Temperature, vol. 5, July-Aug. 1967, p. 594-604. 9 refs. Translation.

Analysis of the relations among the variables of a quasi-one-dimensional plasma flow in crossed electric and magnetic fields, in the case of very small magnetic Reynolds numbers. The results obtained for arbitrarily oriented j and E vectors and arbitrary values of the Hall parameter β are applied to a quantitative study of the processes taking place in the channel of an MHD generator. V. P.

A68-23911 #

EFFECTS OF ELECTRODE AND BOUNDARY-LAYER TEMPERATURES ON MHD GENERATOR PERFORMANCE.

R. Kessler and R. H. Eustis (Stanford University, Stanford, Calif.).

IN: SYMPOSIUM ON ENGINEERING ASPECTS OF MAGNETOHYDRODYNAMICS, 9TH, UNIVERSITY OF TENNESSEE, TULLAHOMA, TENN., APRIL 3-5, 1968, PAPERS.

Symposium sponsored by the Space Institute of the University of Tennessee, the American Institute of Aeronautics and Astronautics, the American Society of Mechanical Engineers, and the Institute of Electrical and Electronics Engineers.

Tullahoma, Tenn., University of Tennessee, Space Institute, 1968, p. 33-40. 10 refs.

USAF-supported research.

Evaluation of experiments performed in a combustion-driven MHD generator to determine the effects of electrode temperature and boundary-layer temperature on its performance. The generator was a single electrode pair guarded to avoid end effects by two electrode pairs both upstream and downstream. It was found that a generator configuration with hot electrodes downstream of the hot walls produced about six times the power of a generator configuration with cold electrodes downstream of cold walls. Electrode voltage drops, obtained from the sidewall probe data, were found to vary with load current, electrode temperature, and upstream wall temperature. Cathode voltage drops were higher than anode voltage drops, but the difference decreased with increasing electrode temperature and upstream wall temperature. P.v.T.

A68-23914 #

SEGMENTED ELECTRODE EFFECTS IN MHD FLOWS WITH HALL CURRENTS.

P. W. Johnson (ARO, Inc., Arnold Air Force Station, Tenn.).
IN: SYMPOSIUM ON ENGINEERING ASPECTS OF MAGNETO-HYDRODYNAMICS, 9TH, UNIVERSITY OF TENNESSEE, TULLAHOMA, TENN., APRIL 3-5, 1968, PAPERS.
Symposium sponsored by the Space Institute of the University of Tennessee, the American Institute of Aeronautics and Astronautics, the American Society of Mechanical Engineers, and the Institute of Electrical and Electronics Engineers.
Tullahoma, Tenn., University of Tennessee, Space Institute, 1968, p. 53, 54.
Contract No. AF 40(600)-1200.

Derivation of formulas which may be used to quantitatively evaluate the effects of nonuniform distribution of currents in segmented-electrode MHD generators and accelerators. Particular attention is given to the case of finite-net axial current and the results are applicable to devices operating in the Hall or slant-wall modes. Expressions are given for the optimum value of the electrode-spacing parameter, the electrode size, and the dissipation along the streamlines. T.M.

A68-23919 #
OPERATION OF A 20 MW HALL GENERATOR.
L. E. Wright, J. B. Carson, Robert H. LaBounty (ARO, Inc., Arnold Engineering Development Center, Arnold Air Force Station, Tenn.), and Joseph Teno (Avco Corp., Avco-Everett Research Laboratory, Everett, Mass.).
IN: SYMPOSIUM ON ENGINEERING ASPECTS OF MAGNETOHYDRODYNAMICS, 9TH, UNIVERSITY OF TENNESSEE, TULLAHOMA, TENN., APRIL 3-5, 1968, PAPERS.
Symposium sponsored by the Space Institute of the University of Tennessee, the American Institute of Aeronautics and Astronautics, the American Society of Mechanical Engineers, and the Institute of Electrical and Electronics Engineers.
Tullahoma, Tenn., University of Tennessee, Space Institute, 1968, p. 78-84.
Contract No. AF 40(600)-1200.

Discussion of the operation of a 20-Mw Hall generator and associated equipment. Support equipment includes an oxidizer system, a fuel system, a cooling water system, a seeder system, an iron core magnet, a ballast, and an exhaust system, each of which is described in detail. The MHD generator, driven by a large rocket engine, was designed to deliver 2000 amp at a voltage level of 10,000 v. The system complexity requires a careful sequencing of subsystems during startup. Certain safety precautions and devices must be incorporated into the operation of such a facility for the protection of personnel and equipment. The control systems include protective devices which terminate a test should a malfunction occur. The handling and storage of fuel and oxidizer generate safety hazards to personnel. A review of both the operational and test instrumentation is presented. (Author)

A68-23920 #
TWO-TERMINAL CONNECTED OPEN CYCLE MHD GENERATORS.
Y. C. L. Wu, D. L. Denzel, S. Witkowski, R. V. Shanklin, III, U. Zitzow, J. Muehlhauser, P. Chang, E. S. Jett, and J. B. Dicks (Tennessee, University, Space Institute, Tullahoma, Tenn.).
IN: SYMPOSIUM ON ENGINEERING ASPECTS OF MAGNETO-HYDRODYNAMICS, 9TH, UNIVERSITY OF TENNESSEE, TULLAHOMA, TENN., APRIL 3-5, 1968, PAPERS.
Symposium sponsored by the Space Institute of the University of Tennessee, the American Institute of Aeronautics and Astronautics, the American Society of Mechanical Engineers, and the Institute of Electrical and Electronics Engineers.
Tullahoma, Tenn., University of Tennessee, Space Institute, 1968, p. 85-98. 12 refs.
Contract No. AF 33(615)-2691.

Presentation of experimental results of two-terminal operation of a 60° diagonal conducting wall generator and a Hall generator under identical gasdynamic channel entrance conditions and magnetic field configurations. The results of the overall performance of these generators are discussed, from open circuit to short circuit conditions as well as detailed measurements of the current distributions over individual electrodes and fluctuations in the Hall generator. In addition, high-speed motion pictures were obtained of the Hall generator electrode surfaces during operation. A number of corrections were applied to the simple one-dimensional theory to take into account the influence of finite segmentation and a model for electrode current-dependent near-electrode sheath potentials. It was found that such corrections enable the prediction of the whole operation range (from open to short circuit) in the cases of the 45° and 60° generators, but that the agreement is still not ideal when it concerns the Hall generator. The Hall generator produces consistently less power than predicted by the theory, and the discrepancy increases as open circuit is approached. (Author)

A68-23921 #
EXPERIMENTAL STUDIES WITH AN ARC-DRIVEN HALL MHD GENERATOR WITH STRONG MHD INTERACTION.
J. E. Klepeis and J. G. Olin (Avco Corp., Avco-Everett Research Laboratory, Everett, Mass.).
IN: SYMPOSIUM ON ENGINEERING ASPECTS OF MAGNETO-HYDRODYNAMICS, 9TH, UNIVERSITY OF TENNESSEE, TULLAHOMA, TENN., APRIL 3-5, 1968, PAPERS.
Symposium sponsored by the Space Institute of the University of Tennessee, the American Institute of Aeronautics and Astronautics, the American Society of Mechanical Engineers, and the Institute of Electrical and Electronics Engineers.
Tullahoma, Tenn., University of Tennessee, Space Institute, 1968, p. 99, 100.
USAF-sponsored research.

Results of experimental studies of the performance of an arc-driven Hall MHD generator at values of the MHD interaction parameter (ratio of Lorenz to inertia forces) up to 1.8 and at theoretical Hall coefficients greater than approximately 3. Tests involved channels with both a circular and rectangular cross section. Channel stall is shown to be the major power-limiting effect, and some solutions to performance constraints are discussed. T.M.

A68-23925 #
AN EXPERIMENTAL STUDY ON WATER-COOLED METAL ELECTRODES OF MHD GENERATOR.
H. Ogiwara, T. Tamaoki, and K. Mawatari (Tokyo Shibaura Electric Co., Ltd., Toshiba Central Research Laboratory, Kawasaki, Japan).
IN: SYMPOSIUM ON ENGINEERING ASPECTS OF MAGNETOHYDRODYNAMICS, 9TH, UNIVERSITY OF TENNESSEE, TULLAHOMA, TENN., APRIL 3-5, 1968, PAPERS.
Symposium sponsored by the Space Institute of the University of Tennessee, the American Institute of Aeronautics and Astronautics, the American Society of Mechanical Engineers, and the Institute of Electrical and Electronics Engineers.
Tullahoma, Tenn., University of Tennessee, Space Institute, 1968, p. 108, 109.

Characteristics of a water-cooled MHD generator, especially performances of electrodes, were studied experimentally. The voltage drops on the surface of water-cooled metal electrodes were deduced from the voltage-current characteristic curves plotted for the case of an externally applied electric field. Probes were inserted through generator channel to determine the profile of electric field, and the voltage drop on the electrode surface was resolved into cathode-drop and anode-drop. The different properties of cathode-drop and anode-drop were discussed, and the mechanism of current supply from the electrodes was considered. (Author)

A68-23929 #
CLOSED CYCLE M.H.D. EXPERIMENTS WITH A LARGE BLOW-DOWN FACILITY.
E. Bertolini, M. Gasparotto, P. Gay, and R. Toschi (Comitato Nazionale per l'Energia Nucleare, Laboratorio Conversione Diretta, Frascati, Italy).
IN: SYMPOSIUM ON ENGINEERING ASPECTS OF MAGNETO-HYDRODYNAMICS, 9TH, UNIVERSITY OF TENNESSEE, TULLAHOMA, TENN., APRIL 3-5, 1968, PAPERS.
Symposium sponsored by the Space Institute of the University of Tennessee, the American Institute of Aeronautics and Astronautics, the American Society of Mechanical Engineers, and the Institute of Electrical and Electronics Engineers.
Tullahoma, Tenn., University of Tennessee, Space Institute, 1968, p. 130-141. 7 refs.

Description of the CNEN MHD experimental facility (an alkali-seeded noble-gas blow-down loop), and discussion of two series of

MHD experiments performed at this facility. The installation is designed to minimize the adverse effects on the generator performance of alkali-metal vaporization and mixing with noble gas, mixture purity level, and plasma insulation from ground, which are not strictly related to the plasma behavior in the MHD duct. The measurements of Faraday and Hall voltages and plasma electrical conductivity in a wide range of the Hall parameter are compared with theory, taking into account the effects of electrode voltage drops, finite segmentation, wall-to-ground loop leakages, and electrothermal instabilities when nonequilibrium ionization is expected. R. B. S.

A68-23931 #
PRELIMINARY EXPERIMENTS ON THE STRIATED-FLOW INDUCTION SYNCHRONOUS MHD GENERATOR.
J. Milewski, J. Stanco, and J. Samulski (Polska Akademia Nauk, Instytut Maszyn Przepływowych, Gdańsk, Poland).
IN: SYMPOSIUM ON ENGINEERING ASPECTS OF MAGNETOHYDRODYNAMICS, 9TH, UNIVERSITY OF TENNESSEE, TULLAHOMA, TENN., APRIL 3-5, 1968, PAPERS.
Symposium sponsored by the Space Institute of the University of Tennessee, the American Institute of Aeronautics and Astronautics, the American Society of Mechanical Engineers, and the Institute of Electrical and Electronics Engineers.
Tullahoma, Tenn., University of Tennessee, Space Institute, 1968, p. 166-168. 8 refs.

Discussion of an attempt to produce an adequate striated flow in an induction-synchronous MHD generator. The method chosen is to create this flow by nonthermal ionization of an inert seeded gas in the internal induced electric field of the generator. It is assumed that the striated flow can be created in the form of a series of conducting rings generated by pulsing an ignition coil with high-frequency ac and that the high-frequency ring discharges can be changed to low-frequency constricted-ring discharges flowing along the duct with the gas. It is concluded that more definite results will be obtained only when the experimentation is conducted at higher working-gas pressure. R. B. S.

A68-23932 #
SOME ASPECTS ON THE OPTIMIZATION OF AN INDUCTIVE MHD CONVERTER.
G. Carpetis, A. Gann, and W. Peschka (Deutsche Versuchsanstalt für Luft- und Raumfahrt, Stuttgart, West Germany).
IN: SYMPOSIUM ON ENGINEERING ASPECTS OF MAGNETOHYDRODYNAMICS, 9TH, UNIVERSITY OF TENNESSEE, TULLAHOMA, TENN., APRIL 3-5, 1968, PAPERS.
Symposium sponsored by the Space Institute of the University of Tennessee, the American Institute of Aeronautics and Astronautics, the American Society of Mechanical Engineers, and the Institute of Electrical and Electronics Engineers.
Tullahoma, Tenn., University of Tennessee, Space Institute, 1968, p. 169, 170.

Demonstration that the performance advantages of the one-wave induction MHD converter may be balanced by the friction losses in the flow channel and the inductive power requirements of the compensating poles. Calculations obtained by use of a computer program based on a two-dimensional analysis show that the overall efficiency and the power factor of the one-wave converter do not exceed those of the uncompensated multiwave converter. R. B. S.

A68-24323 *#
THE FUEL CELL PROBLEM.
Ernst M. Cohn (NASA, Washington, D.C.).
Institute of Electrical and Electronics Engineers, International Convention and Exhibition, New York, N.Y., Mar. 18-21, 1968, Paper. 4 p.

Discussion of the historical background, development, and operation of fuel cells, with special attention devoted to the materials, applications, and engineering problems of fuel cells using hydrogen and oxygen (pure or as air). These problems involve the minimization of the amounts of precious platinum and palladium catalysts, the optimization of electrodes and cell structures, and the problem of high cost per kilowatt. V. Z.

A68-24403 #
A RADIANTLY HEATED RADIOISOTOPE-POWERED THERMIONIC GENERATOR.
J. G. DeSteese and J. S. Holmgren (McDonnell Douglas Corp., Donald W. Douglas Laboratories, Richland, Wash.).
IN: THERMIONIC CONVERSION SPECIALIST CONFERENCE, PALO ALTO, CALIF., OCTOBER 30-NOVEMBER 1, 1967, CONFERENCE RECORD.
Conference sponsored by the Electron Devices Technical Professional Group of the Institute of Electrical and Electronics Engineers.
New York, Institute of Electrical and Electronics Engineers, Inc., 1967, p. 120-129. 9 refs.

Description of a Pm^{147} thermionic generator in which a cylindrical array of planar diodes is mounted in a support structure so that each electrically and thermally isolated emitter faces a central heat source. In this generator, an incandescent radioisotope fuel block radiates heat to the surrounding emitter shoes. High-temperature thermal insulation is used between the diodes to minimize heat transfer to the support structure. This arrangement allows the use of redundant arrays of highly reliable solar energy thermionic (SET) diodes in generators of 100 watts or more electric power output. The use of a monolithic low-power-density fuel block permits a very practical fuel block design. P. v. T.

A68-24872 #
ELECTRODE VOLTAGE DROP IN A SEEDED PLASMA.
Toshitsugu Hara and Motokazu Uchida (Hitachi, Ltd., Mechanical Engineering Research Laboratory, Tokyo, Japan).
Japanese Journal of Applied Physics, vol. 7, Feb. 1968, p. 163-169. 7 refs.

Measurement of the potential distribution in a duct, in the presence of an externally applied voltage. The gas flowing through the duct was a propane/oxygen combustion gas seeded with K_2CO_3 powder. The voltage drop is found to increase with the current density, but to become independent of it above a critical current density. This critical current density and the voltage drop become smaller as the electrode temperature increases. It is concluded that the main causes of the voltage drop are the thin, cold gas layer near the electrode in the region of smaller current densities, and the arc column in the region above the critical current density. M. G.

A68-25596
END REGION OF A SINGLE-LOAD CROSSCONNECTED M.H.D. GENERATOR.
W. T. Norris and J. B. Heywood (Central Electricity Generating Board, Research Laboratories, Leatherhead, Surrey, England).
Institution of Electrical Engineers, Proceedings, vol. 115, Apr. 1968, p. 555-561. 10 refs.

Theoretical, two-dimensional analysis of the end region of a single-load cross-connected MHD generator in which the duct cross section, fluid properties, and magnetic field are uniform. Infinitely fine segmentation of the cross-connected electrode system is assumed. With a single load connected between solid electrodes at each end of the generator, the analysis predicts infinitely high current densities and electric fields at the junction of the solid-electrode and cross-connected sections. It is shown that these infinite concentrations can be removed by using grading resistors near the ends, and the design of one arrangement of grading resistors is discussed. (Author)

A68-25934 #
ENERGY CONVERSION WITH THE AID OF THE MAGNETOCALORIC AND THE ELECTROCALORIC EFFECTS [ENERGIEWANDLUNG MIT HILFE MAGNETOKALORISCHER UND ELEKTROKALORISCHER EFFEKTE].
W. Peschka (Deutsche Versuchsanstalt für Luft- und Raumfahrt, Institut für Energiewandlung und elektrische Antriebe, Stuttgart, West Germany).
Deutsche Gesellschaft für Luft- und Raumfahrt, Symposion über Energieversorgung im Weltraum II, Munich, West Germany, Mar. 14, 1968, Paper. 18 p. 5 refs. In German.

Study of the conversion of the mechanical energy of ferromagnetic, paramagnetic, and diamagnetic materials in magnetic fields to electrical energy by means of an MHD converter. Also inves-

tigated is the conversion of the mechanical energy of a dielectric material to electrical energy by applying the electrocaloric effect. It is shown that only under certain conditions can a diamagnetic material be used in such an energy-conversion process. Two energy-loss mechanisms - ohmic loss and eddy-current loss - are considered for the case of the conversion of the mechanical energy of the magnetic materials. R. B. S.

A68-26140
INTERACTION OF A TRAVELING MAGNETIC FIELD WITH RIGID CONDUCTING SPHERES OR CYLINDERS.
Richard J. Thome (U.S. Army, Electronics Command, Electronic Components Laboratory, Fort Monmouth, N. J.).
IEEE, Proceedings, vol. 55, Dec. 1967, p. 2116-2122. 12 refs.
Contract No. AF 33(615)-3489.

The case of a rigid conducting sphere or cylinder that travels with uniform velocity relative to a two-dimensional, primarily transverse magnetic field with sinusoidal variation in space and time is analyzed to determine the electromechanical characteristics of the interaction. Interest is centered on conductors with diameters small relative to the wavelength of the applied field. For the sphere, an exact solution is not tractable by standard techniques; hence, a method is utilized in which the force is approximated by one of its components. The results are verified by (1) applying the approximation to the analogous case of a cylinder and comparing the result with the exact solution to that case, (2) comparing the limit of the approximate solution for the sphere with the result obtained by assuming the magnetic Reynolds number to be small, and (3) determining the net time-average force of electromagnetic origin experimentally for comparison with the predictions of the theory. The latter were carried out for the cylinder as well as the sphere over a range of magnetic Reynolds numbers ($sR_m = \mu_0 \sigma s \omega D^2$) from 0.4 to 20. In the course of the work, a method is also utilized in which the original "skin effect" problem is reduced to a problem involving interacting low sR_m components and the force is found via the techniques of lumped parameter electromechanics. Situations which may be modeled using the results of this study include holdup or separation of a highly conducting liquid phase from a two-phase flow in heat transfer apparatus as a result of the application of a magnetic field gradient or the energy conversion in a liquid metal magnetohydrodynamic induction machine with a two-phase working fluid. (Author)

A68-27085 #
EXPERIMENTAL INVESTIGATION OF THE CURRENT DENSITY DISTRIBUTION IN A SIMULATED MHD GENERATOR.
Fred W. Fischer (Institut für Plasmaphysik GmbH, Garching, West Germany).
AIAA Journal, vol. 6, May 1968, p. 894-900. 12 refs.
EURATOM-supported research.

In an MHD generator with segmented electrodes, the Hall effect prevents a homogeneous current distribution in the region of the electrodes. The results of calculations of the current density distribution in an inert gas alkali metal plasma using simplifying assumptions were compared with measurements made in a simulated argon-potassium generator. The gas in the generator channel had a temperature of about 2000°K and a pressure of 1.1 atm. The potassium content was 0.22% by weight. The gas velocity did not exceed 130 m/sec, and the magnetic-field strength was held below 4500 gauss. The emf was simulated by applying an electric field of about 15 v across each electrode pair. Measurements of the intensity distribution of the potassium resonance lines permitted conclusions to be drawn with respect to the distribution of electron temperature and thus current density. In general, qualitative agreement with theory was found. The most pronounced deviation from theory occurred near the electrodes, particularly along the insulator between electrodes. The potential distribution measured along the insulator wall was consistent with light-intensity measurements. (Author)

A68-27110 #
ELECTRODE-SIZE EFFECTS IN AN MHD GENERATOR WITH NON-UNIFORM ELECTRICAL CONDUCTION.
M. Mitchner (Stanford University, Dept. of Mechanical Engineering, Stanford, Calif.), D. A. Oliver (Santa Clara, University, Dept. of Mechanical Engineering, Santa Clara, Calif.), and J. R. MacDonald.
AIAA Journal, vol. 6, May 1968, p. 948, 949. 5 refs.
Contract No. AF 33(615)-67-C-1127.

Outline of the use of techniques formulated by two of the authors (Oliver and Mitchner - 1967) to study the effect of electrode size on the performance of an MHD generator with nonuniform electrical conductivity. When the effects of nonuniform conductivity are considered, the internal impedance of a segmented MHD generator becomes sensitive to electrode size; a low-conductivity layer near the wall is seen to increase the optimum electrode size. B. B.

A68-27639
DEVELOPMENT OF A THERMALLY REGENERATIVE SODIUM-MERCURY GALVANIC SYSTEM. II - DESIGN, CONSTRUCTION, AND TESTING OF A THERMALLY REGENERATIVE SODIUM-MERCURY GALVANIC SYSTEM.
I. J. Groce and R. D. Oldenkamp (North American Rockwell Corp., Aerospace and Systems Group, Atomics International Div., Research and Technology Div., Canoga Park, Calif.).
IN: REGENERATIVE EMF CELLS; AMERICAN CHEMICAL SOCIETY, MEETING, 149TH, SYMPOSIUM, DETROIT, MICH., APRIL 8, 9, 1965, PAPERS.
Symposium sponsored by the Division of Industrial and Engineering Chemistry and the Division of Fuel Chemistry of the American Chemical Society.
Washington, D.C., American Chemical Society (Advances in Chemistry Series No. 64), 1967, p. 43-52. 8 refs.
Research sponsored by the North American Aviation Independent Research and Development Program.

Description of the design, construction, and testing of a thermally regenerative energy conversion system using galvanic cells in which liquid-metal streams of sodium and mercury are allowed to combine electrochemically to produce an alloy plus electrical energy. The sodium amalgam stream from the cell battery must be converted to a sodium-rich amalgam and mercury. This is done in the regenerator which distills and separates a mercury fraction, condenses the mercury vapor, cools both streams and recirculates them to the cells. A test loop was built and operated to study these regeneration processes. Two tests were made with the regeneration loop connected to single-matrix thermally regenerative alloy cells - one for 116 hr and the other for 1197 hr. The cell internal resistance did not change during either test, indicating that the cell materials are compatible with the working fluids under flow conditions. T. M.

A68-27650
CHEMICALLY REGENERATIVE, FUEL CELL SYSTEMS.
John M. Matsen (Esso Research and Engineering Co., Linden, N.J.).
IN: REGENERATIVE EMF CELLS; AMERICAN CHEMICAL SOCIETY, MEETING, 149TH, SYMPOSIUM, DETROIT, MICH., APRIL 8, 9, 1965, PAPERS.
Symposium sponsored by the Division of Industrial and Engineering Chemistry and the Division of Fuel Chemistry of the American Chemical Society.
Washington, D.C., American Chemical Society (Advances in Chemistry Series No. 64), 1967, p. 277-291. 46 refs.

Outline of the history of the development of chemically regenerative fuel-cell systems - devices that have long been studied in the hope of circumventing the problems of direct electrochemical reaction of fuels and air. It is concluded that at present regenerative systems are not competitive with direct fuel cells. Works discussed range from Borchers (1894) and Nernst (1913) to Posner (1955) and Austin et al. (1965). B. B.

A68-29145
SECONDARY POWER CONVERSION SYSTEMS.
S. D. Diamond (McDonnell Douglas Corp., Douglas Aircraft Co., Missile and Space Systems Div., Secondary Power Systems Branch, Santa Monica, Calif.).
IN: SPACE SYSTEMS TECHNOLOGY.
Edited by R. D. Heitchue, Jr.
New York, Reinhold Book Corp., 1968, p. 210-257.

Discussion of the functional subsystems - i.e., energy source, power conversion, heat rejection, and power conditioning and dis-

tribution - that constitute a secondary power-conversion system. Closed-cycle dynamic modes of conversion including the Brayton cycle, the Rankine cycle using a variety of condensable working fluids, and the Stirling cycle are discussed. Considerations in the design and selection of secondary power systems, including power requirements, environmental effects, and power system selection, are described. Power systems designed for short duration and emergency power, low-power long-duration systems, moderate-power long-duration systems, and high-power extended duration systems are discussed. M.G.

A68-29186 #
ELECTROMAGNETIC CALCULATION OF AN APPROXIMATE MODEL OF AN INDUCTION MHD MACHINE WITH ALLOWANCE FOR A SECONDARY CIRCUIT [ELEKTROMAGNITNYI RASCHET PRIBLIZHENNOI MODELI INDUKTSIONNOI MGD-MASHINY S UCHETOM VTORICHNOI TSEPI].
Ia. Ia. Valdmanis and Ia. Ia. Lielpeter.
Magnitnaia Gidrodinamika, vol. 4, Jan.-Mar. 1968, p. 114-122. 5 refs. In Russian.
Derivation of analytical expressions for the current-density distribution, electromagnetic induction, power density, and joule losses, both along and across the working channel of an induction MHD machine. The expressions are obtained with the aid of an approximate model of the machine. A numerical and experimental investigation of the electromagnetic-field distribution demonstrates the effectiveness of the model proposed. The merits and drawbacks of various stator windings are examined. V.P.

A68-29187 #
END EFFECT IN CONDUCTION MHD MACHINES IN THE CASE OF BRANCHING OF A PORTION OF THE CURRENT ALONG THE CHANNEL [KONTSEVOI EFFEKT V KONDUKTSIONNYKH MGD-MASHINAKH PRI OTVETVLENII CHASTI TOKA VDOL' KANALA].
Iu. A. Birzvalk.
Magnitnaia Gidrodinamika, vol. 4, Jan.-Mar. 1968, p. 129-137. In Russian.
Discussion of the potential distribution in the channel of a liquid-metal conduction MHD machine in the case where the flow area consists of several electrically series-connected subchannels. The problem of calculating the electromagnetic pressure in such a channel is also examined. It is shown that the potential difference gives rise to parasitic bypass currents along the tubes interconnecting the individual subchannels. V.P.

A68-29309
AN INDUCTION GENERATOR EXPERIMENT.
J. P. Barach and E. J. Sommer, Jr. (Vanderbilt University, Physics Dept., Nashville, Tenn.).
Plasma Physics, vol. 10, May 1968, p. 563-566. 5 refs.
Grant No. AF AFOSR 287-66.
Description of an experiment performed to study an induction MHD generator system. In the induction generator, plasma currents flow freely, electromagnetically inducing currents in the output coil. The obvious advantage of such a system is the absence of electrodes. The disadvantages include low efficiency and the need for operation with a pulsating plasma in order to obtain rapid flux variations. It is pointed out, however, that an induction device can be of interest when a pulsed hot plasma source is available. In the experiment described a hard-core pinch discharge is used to produce a cylindrically expanding blast wave. A dc magnetic field exists in the axial direction, so that circumferential currents are induced in the moving plasma. M.M.

A68-29598 #
INFLUENCE OF THE ELECTRICAL CONDUCTIVITY TENSOR ON THE FLOW IN A GENERATOR WITH FINITE ELECTRODES [INFLUENCE DU TENSEUR DE CONDUCTIVITE ELECTRIQUE SUR L'ECOULEMENT DANS UN GENERATEUR A ELECTRODES FINIES].
Lazar Dragoş (Bucureşti, Universitatea, Bucharest, Rumania).
Cambridge Philosophical Society, Proceedings, vol. 64, Apr. 1968, p. 549-557. 8 refs. In French.
Study of the influence of the electrical conductivity tensor on the motion of a fluid in a MHD generator, under the conditions shown in a preceding work. The problem is also formulated in terms of the theory of distributions and the system of equations which determines the functions $\Psi = \psi + y$ and $\phi = \varphi + \varphi_e$ depends on two parameters λ and ν (equal to $\omega\tau$). Due to the Hall current, the problem is no longer asymmetrical in the variable y, as in the first case, and it therefore has to be separated into an asymmetric and a symmetric problem. By developing a method of successive approximations as against two parameters, it can be shown that the exact solution of the problem can be obtained. M.M.

A68-29729
A UNIFIED THEORETICAL DESCRIPTION OF THERMIONIC CONVERTER PERFORMANCE CHARACTERISTICS.
D. R. Wilkins (General Electric Co., Pleasanton, Calif.).
Journal of Applied Physics, vol. 39, Apr. 1968, p. 2452-2458. 28 refs.
AEC-supported research.
Fundamental principles of molecular chemistry, statistical mechanics, and plasma physics are used to derive theoretical output current and efficiency characteristics of vapor thermionic converters. The results are obtained in terms of basic physical parameters which describe the converter electrodes and interelectrode gas and are in good agreement with corresponding experimental measurements for a broad range of converter operating conditions. The analysis has practical applications for converter physics studies, converter performance evaluations, and thermionic power-plant design. (Author)

A68-29901 #
PERFORMANCE OF THERMOCHEMICALLY DRIVEN MHD CONVERTERS.
Shimshon Frankenthal (American Science and Engineering, Inc., Cambridge, Mass.).
AIAA Journal, vol. 6, June 1968, p. 993-1000. 8 refs.
A slug model for the MHD pulse generator is presented, and the assumptions inherent in it are discussed. In the limit where magnetic diffusion can be ignored, it is shown that the model is governed by a third-order system of differential equations, which is presented cast in a dimensionless form and analyzed. The dimensionless parameters that determine the performance are defined and employed in cataloging the various modes of operation of the system. It is shown that unit conversion efficiency is possible for a wide range of combinations of the system parameters. The role of the load parameter (the ratio of the load resistance to the total circuit resistance) in optimizing the performance is discussed. In a particular mode of operation, the compression of the magnetic field by the slug gives rise to the possibility of operating the device at a reasonable conversion efficiency even though the initial (imposed) magnetic field is small. The excitation requirements in this nearly "self-excited" mode are determined by the inductive component of the load. (Author)

A68-30712
OPTIMUM MHD GENERATOR WITH CHANNEL OF CONSTANT CROSS SECTION.
A. S. Pleshanov and P. P. Lazarev (Akademiia Nauk SSSR, Energeticheskii Institut, Moscow, USSR).
(Teplofizika Vysokikh Temperatur, vol. 5, Sept.-Oct. 1967, p. 907-912.)
High Temperature, vol. 5, Sept.-Oct. 1967, p. 806-810. Translation.
An exact and complete solution is obtained in a quasi-linear approximation with small magnetic Reynolds numbers to the variational problem of the optimization of a linear conduction MHD generator with a channel of constant cross-sectional area S. Optimization is achieved by obtaining a given power N with minimum generalized volume Δ (the parameter of MHD interaction), which

is equivalent to obtaining the maximum of N with a given value of Δ. The working substance is a perfect inviscid electrically conducting gas of zero thermal conductivity, whose electric conductivity $\sigma_{\perp}$ is an arbitrary function of temperature, pressure, and magnetic and electric field strengths. The maximum indices of optimum MHD are compared with those of an MHD generator with fixed parameters. (Author)

A68-30774
A PULSED MAGNETOHYDRODYNAMIC GENERATOR WITH A SUPERCONDUCTING MAGNETIC SYSTEM.
V. A. Kirillin, A. E. Sheindlin, E. I. Asinovskii, V. V. Sychev, V. B. Zenkevich, A. M. Maksimov, and V. A. Al'tov (Akademiia Nauk SSSR, Nauchno-Issledovatel'skii Institut Vysokikh Temperatur, Moscow, USSR).
(Akademiia Nauk SSSR, Doklady, vol. 177, Nov. 1, 1967, p. 77-80.) Soviet Physics - Doklady, vol. 12, May 1968, p. 1059-1061. Translation.
Experimental verification of the theory of a pulse MHD generator employing a superconducting magnetic system. The design and schematic diagram of the generator used in the experiments are described, and a graph showing the distribution of the magnetic inductance along the channel axis is given. Tests in which the magnetic system was disconnected from the generator supply sources and the supply of liquid helium in the cryostat was not replenished showed that the magnetic field intensity remained at a constant level. V.P.

A68-31226 #
THERMODYNAMIC ANALYSIS OF A CLOSED CYCLE WITH AN MHD GENERATOR AND AN MHD COMPRESSOR [TERMODINAMICHESKII ANALIZ ZAMKNUTOGO TSIKLA S MGD-GENERATOROM I MGD-KOMPRESSOROM].
V. L. Iakimenko (Akademiia Nauk SSSR, Institut Atomnoi Energii, Moscow, USSR).
Teplofizika Vysokikh Temperatur, vol. 6, Mar.-Apr. 1968, p. 306-314. 5 refs. In Russian.
Determination of the effect of Joule losses in an MHD generator and an MHD compressor on the efficiency of a closed cycle of thermal-to-electric energy conversion, in which electrical conductivity is maintained by nonequilibrium ionization. The Faraday variant of an MHD channel is discussed, assuming a one-dimensional gas flow and a small magnetic Reynolds number. The Joule losses increase with pressure and reduce sharply the efficiency of the cycle. The parameters for which the cycle has a positive efficiency are determined. V.Z.

A68-31227 #
ELECTROGASDYNAMIC GENERATOR [ELEKTROGAZODINAMICHESKII GENERATOR].
A. T. Belevtsev, Iu. S. Bortnikov, N.S. Lidorenko, G. F. Muchnik, and I. B. Rubashov.
Teplofizika Vysokikh Temperatur, vol. 6, Mar.-Apr. 1968, p. 320-326. 6 refs. In Russian.
Theoretical and experimental investigation of the operation of a device converting the potential or kinetic energy of a moving dielectric medium into electric power. A system of direct conversion of thermal energy into electric power is examined, and some preliminary experimental data are discussed. The analytical and experimental results indicate that the "electrogasdynamic generator" should be able to compete with other existing energy converters. V.P.

A68-31228 #
PECULIARITIES OF MAGNETOGASDYNAMIC CONVERTERS EMPLOYING THE RANKINE CYCLE [OB OSOBENNOSTIAKH USTANOVOK S MAGNITOGAZODINAMICHESKIMI PREOBRAZOVATELIAMI, RABOTAIUSHCHIKH PO TSIKLU RENKINA].
S. A. Mokrushin, R. V. Radchenko, V. G. Stepanov, and A. G. Sheinkman (Ural'skii Politekhnicheskii Institut, Sverdlovsk, USSR).
Teplofizika Vysokikh Temperatur, vol. 6, Mar.-Apr. 1968, p. 327-332. 6 refs. In Russian.
Comparative thermodynamic analysis of MHD generators employing the Brayton and Rankine cycles. It is shown that in the case of nonequilibrium ionization the Rankine cycle will convert at higher MHD-channel Mach numbers than the Brayton cycle. Working fluids particularly suited for use in the Rankine cycle are examined. V.P.

A68-31864
ELECTROMECHANICAL DEVICES FOR ENERGY CONVERSION AND CONTROL SYSTEMS.
Vincent Del Toro (New York, City University, City College, School of Engineering and Architecture, New York, N.Y.).
Englewood Cliffs, N.J., Prentice-Hall, Inc., 1968. 635 p. 39 refs. $13.75.
This text offers an integrated treatment of the theory and operating principles of electromechanical energy-conversion devices. The formulation and development of the essential principles of voltage generation and torque production are treated in a manner which allows for a unified treatment of both ac and dc machines. The means by which torque is produced in such physically different machines as the induction motor, the synchronous machine, and the dc machine are examined and illustrated. Electromechanical components frequently found in control systems are analyzed, including two-phase servomotors, ac tachometer generators, synchros, and induction resolvers. The dynamic behavior of machines is examined both individually and as part of a system. The essential features associated with direct energy-conversion methods are also included, and a comparison of the relative merits of direct energy conversion with the electromechanical method is given. R.B.S.

A68-32685 #
PRESENT SITUATION AND FUTURE PROSPECTS OF CONTROLLED NUCLEAR FUSION [DEN KONTROLLERADE KÄRNFUSIONENS NULÄGE OCH FRAMTIDSUTSIKTER].
Bo Lehnert (Kungl. Tekniska Högskolan, Stockholm, Sweden).
FOA Reports, vol. 1, July 1967, p. 1-14. 28 refs. In Swedish.
Discussion of power production based on controlled fusion of deuterium and tritium nuclei, in order to meet the demands for a strongly enhanced energy consumption. For the controlled release of fusion energy in a reactor, a fully ionized gas of heavy hydrogen has to be kept at a temperature of the order of millions of degrees Kelvin during times of the order of seconds. A self-sustained fusion reaction is therefore only possible if the ionized gas (the plasma) is prevented in a very efficient way from getting into contact with the walls of the reaction chamber. The most promising method in this respect is to use a magnetic field in the shape of a "magnetic bottle" which confines the plasma. In addition to this, methods are required for heating the plasma to the necessary temperature range, as well as a number of technical arrangements for the generation of the magnetic field and the development of the reaction chamber. At the present stage, the fusion problems are mainly the particle losses from the magnetic bottle and the stability of the equilibrium state of the confined plasma. However, there now exist methods for the suppression of some of the most important instabilities in devices where the particle losses have a good chance of being kept at a low level. It is considered possible that thermonuclear fusion research will lead to success within the foreseeable future. P.v.T.

A68-33438
POTENTIAL IN PERFORMANCE IMPROVEMENTS IN AIR BREATHING PROPULSION.
Ernest C. Simpson (USAF, Systems Command, Research and Technology Div., Aero Propulsion Laboratory, Turbine Engine Div., Wright-Patterson AFB, Ohio).
IN: AVIATION AND SPACE: PROGRESS AND PROSPECTS; PROCEEDINGS OF THE ANNUAL AVIATION AND SPACE CONFERENCE, BEVERLY HILLS, CALIF., JUNE 16-19, 1968.

New York, American Society of Mechanical Engineers, 1968, p. 343-350.
Discussion of various parameters (specific fuel consumption, thrust-to-weight ratio, thrust per pound of air being achieved, and

use life of the engine) as they apply to current state-of-the-art for air breathing propulsion. Recent improvements in the field are discussed as they relate to reliability, maintainability, and cost.
M.G.

A68-36891
DIRECT ENERGY CONVERSION.
S. L. Soo (Illinois, University, Urbana, Ill.).
Englewood Cliffs, N.J., Prentice-Hall, Inc., 1968. 346 p. $12.50.

This book covers the basic concepts of direct energy conversion. Following a review of fundamental concepts in thermodynamics, electrochemical effects and fuel cells are discussed with attention drawn to the reversible cell and the ideal fuel cell, the efficiency of a fuel cell, and losses in a fuel cell. Thermionic systems are considered next, with emphasis on the ideal and actual efficiency of a thermionic energy converter. The component effects of thermoelectricity are discussed, including the Seebeck, Peltier, Thomson, Fourier, and Joule effects. The exchange of energy due to displacement of dipoles is then considered, and cases of interaction of thermoelectricity with a magnetic field are treated. The conversion of kinetic or pressure energy of a fluid to electricity by means of MHD devices is discussed, as well as the relationship between fusion plasma generators and direct energy conversion. Criteria for selecting direct-energy-conversion devices for a given application are presented, and general classifications of these devices are made from the points of view of irreversible thermodynamics and the transport of charge carriers.
R.B.S.

A68-37062
THE PLASMA MHD POWER GENERATOR.
Thomas R. Brogan (Colorado State University, Dept. of Mechanical Engineering, Fort Collins, Colo.).
IN: ADVANCES IN PLASMA PHYSICS. VOLUME 1.
Edited by Albert Simon and W. B. Thompson.
New York, Interscience Publishers, Division of John Wiley and Sons, Inc., 1968, p. 227-330. 80 refs.

Discussion of plasma MHD devices for power generation. The electrical properties (electrical conductivity and Hall coefficient) of seeded gases are considered, and the effort to obtain nonequilibrium ionization in an induced electric field is examined. Developments in the design, performance, and technology of MHD generators are described, with primary emphasis on the combustion-driven MHD generators on which most of these developments occurred - including rocket-driven MHD generators such as the Mark V Prototype and the LORHO Pilot 20 MW generators.
R.A.F.

A68-37310 #
ELECTROSTATIC PROBE MEASUREMENTS IN FLOWING NaK-SEEDED ARGON.
Harris B. McKee and M. Mitchner (Stanford University, Dept. of Mechanical Engineering, Stanford, Calif.).
AIAA Journal, vol. 6, Aug. 1968, p. 1587-1589. 15 refs.
Contract No. AF 49(638)-1695.

Experimental study of the current-voltage characteristics of closed-cycle MHD generators using a cooled cylindrical probe in a low-velocity atmospheric-pressure argon flow seeded with NaK (90% K by weight). Probe experiments were conducted in the upstream plenum of an inert-gas MHD generator operating with arc-heated argon. It was found that the current collected by the probe depended strongly on the probe temperature, which ranged from 350 to 1000 K, and that above 450 K the collected currents were considerably larger than those predicted by present probe theory or by thermionic emission.
R.E.L.

A68-38740
HIGH TEMPERATURE PLASMAS AND CONTROLLED FUSION [LES PLASMAS A HAUTE TEMPERATURE ET LA FUSION CONTROLEE].
M. Trocheris (EURATOM and Commissariat à l'Energie Atomique, Groupe de Recherches sur la Fusion, Fontenay-aux-Roses, Hauts-de-Seine, France).
IN: STATES OF MATTER UNDER THE EXTREME EFFECTS OF VERY HIGH AND VERY LOW TEMPERATURES, AND VERY HIGH AND VERY LOW PRESSURES; INSTITUT FRANÇAIS DES COMBUSTIBLES ET DE L'ENERGIE, INTERNATIONAL CONFERENCE, 7TH, PARIS, FRANCE, APRIL 4-8, 1967, PROCEEDINGS [ETATS DE LA MATIERE SOUS LES EFFETS EXTREMES DES TRES HAUTES ET TRES BASSES TEMPERATURES, TRES HAUTES ET TRES BASSES PRESSIONS; INSTITUT FRANÇAIS DES COMBUSTIBLES ET DE L'ENERGIE, JOURNEES INTERNATIONALES, 7TH, PARIS, FRANCE, APRIL 4-8, 1967, PROCEEDINGS].

Edited by Marcel Véron.
Paris, Institut Français des Combustibles et de l'Energie, 1968, p. 27-34; Discussion, Marcel Véron (Conservatoire National des Arts et Métiers, Paris, France), N. Kurti (Oxford University, Oxford, England), and J. L. Delcroix (Paris, Université, Faculté des Sciences, Orsay, Essonne, France), p. 35. In French.

Discussion of high-temperature plasmas and attempts to achieve controlled thermonuclear fusion. If all the types of preparatory experiments are included, densities experimented with range from 10^9 to 10^{17} cm^{-3}, while the temperatures run from 10^5 to 10^9 K. In spite of these large spreads, plasmas from fusion laboratories have important common properties. In particular, they are classic plasmas: their phase density is always much smaller than the limiting density h^{-3} which corresponds to a Fermi gas at absolute zero, h being Planck's constant. The dimensionless parameter $n\lambda^3{}_D$, the number of the particles in a cube with a side equal to the Debye length, is much greater than unity, which implies that the plasma is an assemblage of relatively independent particles, the positions of which in phase space are weakly correlated, and which are displaced approximately according to the effect of a common electromagnetic field.
F.R.L.

A68-39715 #
EFFECTS OF ELECTRODE AND BOUNDARY-LAYER TEMPERATURES ON MHD-GENERATOR PERFORMANCE.
R. Kessler and R. H. Eustis (Stanford University, Dept. of Mechanical Engineering, Stanford, Calif.).
AIAA Journal, vol. 6, Sept. 1968, p. 1640-1646. 10 refs.
USAF-supported research.

Investigation of energy transfer in the MHD generator from the working fluid to an external load by means of electrodes. Experiments are performed in a combustion driven generator to determine the effects of electrode temperature on its performance. The electrodes are held at three temperature levels of 775, 1475, and 11,685 K, by controlling individual cooling circuits. Two electrode boundary-layer temperature profiles were investigated: one resulting from a hot (2400 K) upstream wall, and the other resulting from a cold (750 K) water-cooled plate that replaced the normal upstream electrode wall. Probes are installed in the insulator side wall between the center pair of electrodes to measure the voltage profile in the gas. It is found that (1) electrode temperature is an important factor in determining the MHD generator performance, (2) the cathode voltage drops are caused by surface-sheath effects and gasdynamic effects, and (3) the voltage drops are primarily gasdynamic and may be roughly predicted from calculation based upon integration of an equilibrium conductivity profile through the boundary layer to a point one Debye length from the electrode surface.
Z.W.

A68-39717 #
MHD GENERATOR IN TWO-TERMINAL OPERATION.
Y. C. L. Wu, J. B. Dicks, D. L. Denzel, S. Witkowski (Tennessee, University, Space Institute, Tullahoma, Tenn.), R. V. Shanklin, III, U. Zitzow (J. B. Dicks and Associates, Tullahoma, Tenn.), P. Chang, and E. S. Jett.
AIAA Journal, vol. 6, Sept. 1968, p. 1651-1657. 13 refs.
Contract No. AF 33(615)-2691.

Experimental results of a two-terminal connected, 60° diagonal conducting wall (DCW) generator and a Hall generator under identical channel entrance conditions. The governing equations for two-terminal connected, MHD generators were derived under the assumption of homogeneous electrical properties and with corrections, including the finite size of electrodes. A comparison of the outlined

theory with the experimental results shows that other losses not included in the theory can be represented by a factor reducing the induced emf of the generator. (Author)

A68-39722 #
ELECTRICAL CHARACTERISTICS OF A LINEAR, NONEQUILIBRIUM, MHD GENERATOR.
Bert Zauderer and Eric Tate (General Electric Co., King of Prussia, Pa.).
(SYMPOSIUM ON ENGINEERING ASPECTS OF MAGNETOHYDRODYNAMICS, 8TH, STANFORD UNIVERSITY, STANFORD, CALIF., MARCH 28-30, 1967, PRESENTATIONS, p. 89-99.)
AIAA Journal, vol. 6, Sept. 1968, p. 1685-1694. 18 refs.
Navy-supported research.

Experiments were performed to isolate the primary causes of the Hall voltage reduction in large Hall parameter ($\omega\tau$), linear MHD generators. The MHD generator working fluid was either shock heated xenon or a shock heated 9.2% carbon monoxide - 90.8% xenon gas mixture. The $\omega\tau$ values in the generator ranged from 1 to 10. The transverse current level per electrode was varied for 10 amp at which Lorentz force and nonequilibrium effects were negligible to 140 amp at which both effects were appreciable. At all current levels, optical observations show that the current in the generator is concentrated in streamers. However, at the lower current levels it was possible to obtain reasonably good agreement with a uniform nonequilibrium plasma, MHD generator theory. At higher current levels the experimental Hall voltage was below the values predicted by this theory. The deviation increased with increasing Lorentz force. It was optically observed that nonuniform electrode conduction sharply increased the current density and hence the Lorentz force near the electrodes. Thus it is concluded that in the present experiments the Lorentz force is the primary factor in reducing the Hall voltage. (Author)

A68-39723 *#
VARIABLE-VELOCITY MHD INDUCTION GENERATOR WITH ROTATING-MACHINE INTERNAL ELECTRICAL EFFICIENCY.
David G. Elliott (California Institute of Technology, Jet Propulsion Laboratory, Propulsion Research and Advanced Concepts Section, Pasadena, Calif.).
AIAA Journal, vol. 6, Sept. 1968, p. 1695-1702. 5 refs.

A traveling-wave, MHD induction generator with varying fluid velocity between inlet and exit can have the same internal electrical efficiency as a rotating induction generator. The fraction of electric retarding work converted to electric output at each station in the flow channel is $(1 + s)^{-1}$, where s is the local slip $(U - U_s)/U_s$ between the velocity of the fluid U and the velocity of the zero-crossing of the magnetic field wave U_s. To produce the rotating-machine efficiency, the product of magnetic field amplitude, wave velocity, and flow channel width is held constant from inlet to exit. The local slip can be freely chosen for maximum electric output from the fluid in the presence of friction, and the inlet magnetic field can be selected for maximum output after winding and end losses. An efficiency of 0.63 is found possible with a 325-kW lithium generator. (Author)

A68-39724 #
OPTIMIZATION STUDIES ON OPEN-CYCLE MHD GENERATORS.
C. Carter and J. B. Heywood (Central Electricity Generating Board, Research Laboratories, Leatherhead, Surrey, England).
AIAA Journal, vol. 6, Sept. 1968, p. 1703-1711. 9 refs.

An optimization theory that predicts the variation of thermodynamic properties, duct shape, and electrical loading along an MHD generator for minimum duct length, duct surface area, or duct volume is developed. The model is based on the one-dimensional flow equations including heat transfer and friction, and the analysis is developed for a fluid with arbitrary dependence of density, enthalpy, electrical conductivity, and mobility on temperature and pressure. Four types of electrical loading of the generator are considered - the segmented-electrode Faraday generator; and the cross-connected generator, first with constant cross-connection angle and multiple load connections; then with a single load; and finally with constant cross-connection angle and with single load. This theory is then applied to the design of an open-cycle MHD generator for a 2000-MW power plant. Numerical results for these four different types of generator are calculated with a computer program and compared, with particular emphasis on the loading parameter variation. It is concluded that the additional constraints of constant cross-connection angle and single load do not significantly affect the overall generator performance, although they do modify the parameter variation along the duct. (Author)

A68-39726 #
SOME DIAGNOSTIC TECHNIQUES USEFUL FOR MHD-GENERATOR PLASMAS.
R. Wienecke (Institut für Plasmaphysik GmbH, Garching, West Germany).
AIAA Journal, vol. 6, Sept. 1968, p. 1724-1727. 12 refs.

The plasma in an MHD generator is mainly defined by its electron density n_e, its electrical conductivity σ, the temperatures of the gas and the electrons T_0 and T_e, its velocity v, and the value of the Hall coefficient $\omega\tau$. Various diagnostic methods have been developed in recent years to determine and clarify the behavior of such generators, which are described. (Author)

A68-40538
THE EFFECT OF LOCAL NON-EQUILIBRIUM IONIZATION IN A SEGMENTED ELECTRODE MHD GENERATOR.
M. G. Haines (London, University, Imperial College of Science and Technology, Physics Dept., London, England).
Plasma Physics, vol. 10, Aug. 1968, p. 787-797. 18 refs.

Study of the achievement of a high effective electrical conductivity and hence high power densities in closed-cycle MHD power generation. The effect of local nonequilibrium ionization in a segmented electrode MHD generator is considered. It is shown that when the electrical conductivity is proportional to the local ohmic heating, through both being proportional to the local nonequilibrium electron density, a segmented MHD duct behaves poorly at large Hall parameter. In fact, the ratio of Hall electric field to Faraday electric field is then less than $1/\beta$. Methods of overcoming this effect are discussed. M.G.

A68-41161 #
MHD POWER GENERATION USING AN RF-GENERATED NONEQUILIBRIUM PLASMA.
J. R. Dworschak and H. E. Brandmaier (Curtiss-Wright Corp., Wood-Ridge, N.J.).
AIAA Journal, vol. 6, Oct. 1968, p. 2021-2023.

Study of the use of a highly nonequilibrium plasma generated by inductively-coupled rf electric fields, in an MHD power generator operated at a subatmospheric pressure and a high effective Hall parameter but with a moderate magnetic field. Further studies must be made to develop more sophisticated diagnostic techniques for the measurement of rf-generated plasmas and to fully evaluate the potential of these techniques in MHD devices. R.M.

A68-41217 *
MATERIALS RESEARCH PROBLEMS IN THE DIRECT CONVERSION OF THERMAL RADIATIVE AND CHEMICAL ENERGY INTO ELECTRICITY.
Fritz Wald and Martin Weinstein (Tyco Laboratories, Inc., Waltham, Mass.).
IN: ENERGISTIC MATERIALS: ENERGY TO THE BENEFIT OF AEROSPACE AND MANKIND; SOCIETY OF AEROSPACE MATERIAL AND PROCESS ENGINEERS, NATIONAL SYMPOSIUM AND EXHIBIT, 13TH, CHICAGO, ILL., MAY 7-9, 1968, PROCEEDINGS.

North Hollywood, Calif., Western Periodicals Co. (SAMPE Science of Advanced Materials and Process Engineering Proceedings. Volume 13), 1968, p. 337-368. 64 refs.
Contracts No. NAS 5-9149; No. N 00014-66-C-0147.

Evaluation of direct energy conversion methods such as thermoelectricity, solar cells, thermionics, and fuel cells, which are presently in a state of development where their practical and commercial

use for the solution of various specialized power supply systems is possible. A number of problems, particularly in materials, are however still hindering the most effective use of such devices. The general mechanisms of electric-energy production in the four cases are discussed. Recent research results are considered. P.v.T.

A68-41271 #
INVESTIGATION OF THE INFLUENCE OF THROTTLING ON THE EFFICIENCY OF A RANKINE CYCLE WITH AN MHD GENERATOR [ISSLEDOVANIE VLIIANIIA DROSSELIROVANIIA NA K. P. D. TSIKLA RENKINA S MGD-GENERATOROM].
V. A. Ovcharenko, P. P. Orlov, and S. M. Chernyshev (Akademiia Nauk SSSR, Nauchno-Issledovatel'skii Institut Vysokikh Temperatur, Moscow, USSR).
Teplofizika Vysokikh Temperatur, vol. 6, July-Aug. 1968, p. 595-598. 12 refs. In Russian.
Thermodynamic analysis of an MHD generator employing the Rankine cycle, for the case where mercury, lithium, or potassium is used as the working fluid. In the case of mercury, it is shown that in the superheated vapor region, the cycle efficiency is practically independent of throttling. This makes it possible to select the upper pressure of the cycle without considering the channel pressure. For potassium and lithium, throttling is found to lead to a decrease in efficiency. V. P.

A68-41272 #
CLOSED-LOOP CYCLE COMPOSED OF AN MHD GENERATOR AND A COMPRESSOR WITH A HEAVY-GAS FLOW [ZAMKNUTYI TSIKL-MGD-GENERATOR I KOMPRESSOR S POTOKOM TIAZHELOGO GAZA].
V. L. Iakimenko (Akademiia Nauk SSSR, Institut Atomnoi Energii, Moscow, USSR).
Teplofizika Vysokikh Temperatur, vol. 6, July-Aug. 1968, p. 607-614. 10 refs. In Russian.
Analysis of a converter of thermal into electric energy operating in a closed-loop cycle. Cycles are examined in which the working fluid, after passing through an MHD generator and a cooler, is compressed by means of the energy released by the generator or, in the case of a jet-type compressor, by means of an accelerated flow of a gas heavier than the working fluid. Since the compressor operation involves consumption of thermal rather than electric energy, the efficiency of a cycle incorporating a jet-type compressor decreases moderately with increasing Joule and hydraulic losses, and can still be as high as 10 to 15% in the case of losses for which a converter employing a compressor using electric energy supplied by the generator will exhibit a negative efficiency. V. P.

A68-41790 #
INVESTIGATION OF PLASMA EXPANSION IN A UNIFORM FIELD AND SHOCK FORMATION DUE TO A MAGNETIC BARRIER.
Yasunori Miyoshi and Yukio Okamoto (Nagoya Institute of Technology, Nagoya, Japan).
Japanese Journal of Applied Physics, vol. 7, Aug. 1968, p. 927-935. 15 refs.
Research sponsored by Nagoya University.
Investigation of the influence of the initial parameters on the behavior of a plasma expanding along a uniform guide field, and consideration of the processes whereby the kinetic energy of the plasma flow is converted to thermal energy by a shock wave due to a magnetic barrier. The longitudinal expansion of a plasma in a uniform guide field is accompanied by a decrease in density and temperature. The temperature decrease is smaller than the density decrease. This seems to be in agreement with a model, which has been applied in the Bille en Tête experiment. A shock wave propagates in the upstream direction accompanying the temperature and density increase behind the shock front. This phenomenon is clearer in the case of a plasma with lower density and higher temperature. M. M.

A68-42500
MAGNETOHYDRODYNAMIC ENERGY CONVERSION.
R. J. Rosa (Avco Corp., Avco-Everett Research Laboratory, Everett, Mass.).
New York, McGraw-Hill Book Co., 1968. 246 p. $17.50.
This volume reviews the basic principles and practical aspects of MHD energy conversion for graduate students and engineers interested in applied MHD. Detailed explanations and derivations from first principles are avoided, although the principal characteristics of an MHD generator, the basic concepts, and the magnetic Reynolds numbers are treated. Ionization and conductivity are treated, and the basic equations and general features of fluid mechanics are described. Hall and ion slip effects are investigated with regard to the engineering consequences. Design considerations are noted, and practical applications such as rocket generators, cavity reactors, radiating power plants, and propellant-cooled propulsion systems in the aerospace field are discussed. The appendices give transport properties in a multicomponent gas; calculated curves of conductivity and Hall parameters, magnetic strengths, constants; and a method for the calculation of the generator performance. R.M.

A68-42507
IECEC '68; INTERSOCIETY ENERGY CONVERSION ENGINEERING CONFERENCE, UNIVERSITY OF COLORADO, BOULDER, COLO., AUGUST 13-17, 1968, RECORD. VOLUME 1.
New York, Institute of Electrical and Electronics Engineers, Inc. (IEEE Publication 68 C 21-Energy), 1968. 1069 p.
Members, $25.; nonmembers, $35.

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BRAYTON CYCLE.
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THIN-FILM MULTIKILOWATT SOLAR ARRAYS. W. Luft and R. A. Boring (TRW Systems Group, Redondo Beach, Calif.), p. 560-570. 7 refs.

LUNAR SURFACE SOLAR ARRAY CHARACTERISTICS. R. Boring (TRW Systems Group, Redondo Beach, Calif.), p. 571-579. 7 refs.

LARGE SOLAR ARRAYS FOR MULTI-MISSION LUNAR SURFACE EXPLORATION. J. E. Boretz (TRW Systems Group, Redondo Beach, Calif.) and J. L. Miller (NASA, Marshall Space Flight Center, Huntsville, Ala.), p. 580-591. 9 refs.

DEVELOPMENT OF INTERCONNECTABLE SOLAR PANELS FOR LARGE-ARRAY SYSTEMS. Larry G. Chidester and Jerry A. Mann (Lockheed Aircraft Corp., Palo Alto, Calif.), p. 592-599.

METHODS FOR FABRICATING CdS THIN-FILM SOLAR CELL MODULES. A. F. Ratajczak (NASA, Lewis Research Center, Cleveland, Ohio), F. A. Blake, and M. R. Stahler (General Electric Co., Philadelphia, Pa.), p. 600-606.

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LIQUID METAL MHD POWER GENERATION. William D. Jackson (Avco Corp., Everett, Mass.), p. 1024-1032. 22 refs.

POWER NEEDS FOR ELECTRIC PROPULSION. William R. Mickelsen (Colorado State University, Fort Collins, Colo.), p. 1033-1043. 27 refs.

A68-42517

A LITHIUM/TIN CELL WITH AN IMMOBILIZED FUSED-SALT ELECTROLYTE - CELL PERFORMANCE AND THERMAL REGENERATION ANALYSIS.
H. Shimotake and E. J. Cairns (Argonne National Laboratory, Argonne, Ill.).
IN: IECEC '68; INTERSOCIETY ENERGY CONVERSION ENGINEERING CONFERENCE, UNIVERSITY OF COLORADO, BOULDER, COLO., AUGUST 13-17, 1968, RECORD. VOLUME 1.

New York, Institute of Electrical and Electronics Engineers, Inc. (IEEE Publication 68 C 21-Energy), 1968, p. 76-91. 45 refs. AEC-sponsored research.

Consideration of the lithium-tin system for use as a thermally regenerative cell. Current density-voltage curves for lithium-tin cells with an immobilized electrolyte are given for various operating conditions. The electrolyte immobilization is accomplished by use of a high-specific-area ceramic filler material for the formation of a rigid paste electrolyte. Because of the low lithium partial pressure under regeneration conditions, special regenerator designs are required. Integrated cell-regenerator system designs are discussed. Design calculations indicate that it should be possible to operate regenerators at rates corresponding to 10 to 40 A/cm^2 at pressures ranging from 1 to 2 torr, provided that care is taken in minimizing vapor-phase pressure losses. Near 1200°C, some refractory metals such as tungsten, molybdenum-tungsten alloys, and others are suitable with liquid tin. It is reasonable to expect that complete thermally regenerative systems in the size range from 1 to 10 kW will have specific power capabilities of 2 to 20 W/lb, excluding the heat-source weight. F.R.L.

A68-42528

SNAP 29 HEAT SOURCE DESIGN AND DEVELOPMENT.
William W. Wachtl (Martin Marietta Corp., Aerospace Group, Nuclear Div., Baltimore, Md.).
IN: IECEC '68; INTERSOCIETY ENERGY CONVERSION ENGINEERING CONFERENCE, UNIVERSITY OF COLORADO, BOULDER, COLO., AUGUST 13-17, 1968, RECORD. VOLUME 1.

New York, Institute of Electrical and Electronics Engineers, Inc. (IEEE Publication 68 C 21-Energy), 1968, p. 194-199.

The SNAP 29 is a radioisotope thermoelectric generator RTG for space application. The SNAP 29 heat source supplies thermal

energy to the RTG conversion system, utilizing the radioisotope decay energy of polonium 210. The heat source is composed of a fuel block capsule assembly and the design is constrained by operational performance requirements and additional safety considerations. The design details and associated development are presented for the fuel block and capsules. Extensive development and testing have established structural requirements and capsule/fuel-block compatibility with their environments. (Author)

A68-42571 *
LOW-VOLTAGE CONVERSION FROM PRIMARY AND SECONDARY SOURCES.
E. R. Pasciutti (NASA, Goddard Space Flight Center, Greenbelt, Md.).
IN: IECEC '68; INTERSOCIETY ENERGY CONVERSION ENGINEERING CONFERENCE, UNIVERSITY OF COLORADO, BOULDER, COLO., AUGUST 13-17, 1968, RECORD. VOLUME 1.

New York, Institute of Electrical and Electronics Engineers, Inc. (IEEE Publication 68 C 21-Energy), 1968, p. 653-661.

Single-cell batteries combined with low-input-voltage dc-to-dc conversion-regulation (LIVCR) can have advantages as a long-life energy-storage system. A simple, effective circuit technique was developed to improve push-pull-inverter crossover reliability, efficiency, and source ripple. It uses full-cycle base drive, which essentially eliminates the problems of transistor storage time. An approach using a configurational-current feedback inverter which protects against destructive saturation-current surges from the output transformer was also developed; this has important use in applications involving low-impedance sources. Sources having different output characteristics are functionally integrated into a hybrid-source application using the special LIVCRs developed, which are operationally adaptable to each source subsystem while enhancing the reliability and efficiency of the overall power-supply system. (Author)

A68-42581
PLASMA MHD POWER GENERATION.
R. J. Rosa (Avco Corp., Avco-Everett Research Laboratory, Everett, Mass.).
IN: IECEC '68; INTERSOCIETY ENERGY CONVERSION ENGINEERING CONFERENCE, UNIVERSITY OF COLORADO, BOULDER, COLO., AUGUST 13-17, 1968, RECORD. VOLUME 1.

New York, Institute of Electrical and Electronics Engineers, Inc. (IEEE Publication 68 C 21-Energy), 1968, p. 1017-1023. 40 refs.

Review of the principles of MHD power generation, possible commercial and space applications, and present status. A simple form of MHD generator consists of a duct through which the gaseous working fluid flows, coils which produce a magnetic field across the duct, and electrodes at the sides of the duct. The advantages are that it is a basically simple and rugged device capable of handling enormous power levels at temperatures that would quickly destroy any other energy-conversion device. Of great significance for the future is the potential reduction of thermal pollution, due to the potential high efficiency of MHD power plants. It is considered that eventually the MHD conversion device and the nuclear heat source will be combined. F.R.L.

A68-42582
LIQUID METAL MHD POWER GENERATION.
William D. Jackson (Avco Corp., Avco-Everett Research Laboratory, Everett, Mass.).
IN: IECEC '68; INTERSOCIETY ENERGY CONVERSION ENGINEERING CONFERENCE, UNIVERSITY OF COLORADO, BOULDER, COLO., AUGUST 13-17, 1968, RECORD. VOLUME 1.

New York, Institute of Electrical and Electronics Engineers, Inc. (IEEE Publication 68 C 21-Energy), 1968, p. 1024-1032. 22 refs.

Review of the principles of liquid-metal MHD power generation. Several possible power cycles are described, and the characteristics of liquid-metal MHD generators are discussed. With liquid metals the magnetic Reynolds number is high enough so that direct ac generation is possible. An MHD version of the induction generator has generally been favored for the extraction of electrical energy, although some work has also been done with Faraday-type dc generators. An obvious candidate for the role of the heat source in liquid metal MHD systems is a liquid-cooled reactor of either the fast-breeder or thermo type, although a fossil-fuel-fired light-metal boiler has also been proposed. It is considered that the prospects for application of MHD power cycles operating with liquid metals to high-power space systems in the relatively near future seem promising. F.R.L.

A68-42954
THERMOELECTRIC-THERMOMAGNETIC ENERGY CONVERTER STAGING.
C. F. Kooi, R. B. Horst, and K. F. Cuff (Lockheed Aircraft Corp., Lockheed Missiles and Space Co., Research Laboratories, Palo Alto, Calif.).
Journal of Applied Physics, vol. 39, Aug. 1968, p. 4257-4263. 12 refs.

Description of an exact theory of staging of heat engines or coolers for the case where the individual stage efficiencies or performance coefficients are functions only of the fractional temperature difference $\Delta T/T$ between the hot and cold sides of the stage. In this case, for an extremum in efficiency or performance coefficient, the fractional temperature differences of each stage are equal. Exact expressions are given for the efficiency and the performance coefficient for a single stage and an infinitely staged device and for the shape of the infinitely staged device. M.G.

A68-43067
MHD INDUCTION GENERATOR.
S. J. Dudzinsky (RAND Corp., Santa Monica, Calif.) and T. C. Wang (TRW Systems Group, Space Electric Power Laboratory, Redondo Beach, Calif.).
IEEE, Proceedings, vol. 56, Sept. 1968, p. 1420-1431. 321 refs.

This paper reviews, in some detail, the general theory of MHD induction generators. Several different approaches to the analysis of constant-velocity generators are summarized and compared, and a new mathematical model for a variable-velocity generator is presented, including digital computer solutions for the theoretical performance. The velocity distribution and boundary-layer losses are considered separately, and the problem of end effect is discussed qualitatively. Recent experimental results for both separately excited and self-excited MHD induction generators are summarized, and the future of MHD induction generators is discussed briefly. (Author)

A68-43068
AN ANALYSIS OF THE OPERATION AND STABILITY OF THE CONSTANT-VELOCITY MHD HALL GENERATOR.
John H. Carey (Dynatech Corp., Fluid and Thermal Engineering Dept., Cambridge, Mass.) and William F. Hughes (Carnegie-Mellon University, Dept. of Mechanical Engineering, Pittsburgh, Pa.).
IEEE, Proceedings, vol. 56, Sept. 1968, p. 1438-1448. 6 refs.

The constant-velocity Hall-type MHD generator with segmented transverse electrodes is analyzed numerically to determine the steady-state operating characteristics and the stability with respect to axially propagating magnetoacoustic waves under a constant-current constraint. The electrical conductivity and Hall parameter are represented as functions of temperature and pressure. The variations of steady-state parameters are displayed graphically and terminal characteristics are presented. Phase velocity and amplitude data for the magnetoacoustic waves are presented in terms of steady-state parameters under a short-wavelength approximation. Three wave modes are predicted, two which damp and one which grows. For initially subsonic conditions, the two damped waves propagate downstream and the amplified one propagates upstream, which may cause choking. For initially supersonic flow the three waves all travel downstream. (Author)

A68-43071
ELECTRODE PROCESSES IN MHD GENERATORS.
R. C. Adams (Standard Telephones and Cables, Ltd., Valve Div., Paignton, Devon., England) and Eric Robinson (English Electric Co., Ltd., Nelson Research Laboratories, Stafford, Staffs., England).
IEEE, Proceedings, vol. 56, Sept. 1968, p. 1519-1535. 28 refs.

Electrode processes strongly influence the performance and durability of an MHD generator. A theoretical analysis of these processes is made based on a model suggested by experimental work. According to these observations current transfer at the cathode usually occurs by means of small arc spots, while at the anode the discharge covers the electrode. The basic relations resulting from an energy balance within these discharges, Poisson's equation for space charge, and the electrical and thermal boundary conditions are derived in terms of the properties of the ambient gas. The calculation of these properties for MHD duct gases is then described and special attention given to the perturbation of the ionization equilibrium resulting from charge transport within the discharge. Preliminary results of computer programs designed to carry out the calculation for open and closed cycle duct conditions are presented, and it is shown that under certain conditions the discharge part of the calculation can be presented as a unique set of curves, from which the running conditions and erosion can be calculated for any electrode material. (Author)

A68-43072
AN ANALYSIS OF THE ANNULAR INDUCTION MHD GENERATOR.
Martin J. McCutcheon (Alabama, University, Div. of Engineering, Birmingham, Ala.) and Denys O. Akhurst (Arkansas, University, Electrical Engineering Dept., Fayetteville, Ark.).
IEEE, Proceedings, vol. 56, Sept. 1968, p. 1584, 1585. 6 refs.
Contract No. DA-01-021-AMC-12820(Z).

The analysis is made for a constant-amplitude traveling magnetic field interacting with a constant-velocity fluid flowing in an annular channel. The expressions for input and output densities, electrical conversion efficiency, and generator phase impedance are given. The machine parameters and effects are included through the use of ac machinery concepts. The results are then compared with those for a generator having a rectangular channel. (Author)

A68-44312
FUEL CELLS AND FUEL BATTERIES: A GUIDE TO THEIR RESEARCH AND DEVELOPMENT.
H. A. Liebhafsky (Texas Agricultural and Mechanical University, College Station, Tex.) and E. J. Cairns (Argonne National Laboratory, Argonne, Ill.).
Research sponsored by the U.S. Army.
New York, John Wiley and Sons, Inc., 1968. 701 p.
$27.50.

This book is a guide to the research and development of fuel cells and fuel batteries. The fundamentals underlying all fuel cells are treated in detail, stressing understanding and not technical particulars. The first half of the book builds a foundation on thermodynamics, irreversible processes, overvoltage, electrocatalysis, and transport phenomena. Special emphasis is given to the hydrogen anode and the oxygen cathode. The second half of the book is devoted to a detailed consideration of the various types of fuel cells, including those using hydrogen, compromise fuels (such as hydrazine, methanol, and reformer gases), and hydrocarbons. Molten-carbonate cells and cells with oxide-ion electrolytes are treated separately. A complete history and description of the Gemini fuel battery, the most successful of these new power sources, is given. P.G.M.

A68-44776
HANDBOOK OF FUEL CELL TECHNOLOGY.
Edited by Carl Berger.
Englewood Cliffs, N.J., Prentice-Hall, Inc., 1968. 620 p.
$18.50.

CONTENTS:

A68-44779
LOW TEMPERATURE-LOW PRESSURE FUEL CELL WITH CARBON ELECTRODES.
K. V. Kordesch (Union Carbide Corp., Development Dept., Parma, Ohio).
IN: HANDBOOK OF FUEL CELL TECHNOLOGY.
Edited by Carl Berger.
Englewood Cliffs, N.J., Prentice-Hall, Inc., 1968, p. 359-421.
64 refs.

Practical survey of the present state of carbon fuel-cell technology. Basic theory is briefly discussed in terms of the laws of physical chemistry, and theoretical examples are given to show the connection between theory and practice. Manufacturing processes are described for three types of carbon electrodes. Performance data are restricted to hydrogen-oxygen (air) fuel cells with alkaline electrolytes. The carbon electrode fuel-cell system has, in addition to its simplicity and good electrochemical characteristics, the advantage of low cost, which enables it to compete with established power sources. F.R.L.

A68-45718 *#
A REVIEW OF THE ALKALI METAL RANKINE TECHNOLOGY PROGRAM.
S. V. Manson (NASA, Office of Advanced Research and Technology, Nuclear Power Systems Branch, Washingtin, D.C.).
Journal of Spacecraft and Rockets, vol. 5, Nov. 1968, p. 1249-1259.
120 refs.

Treatment of the status of the alkali metal Rankine turbogenerator program in three phases: basis technology with particular regard to critical areas; component technology; and system technology. The power plant for which technology is currently being developed consists of four loops: a Li primary loop, a K power-conversion loop, a NaK heat-rejection loop, and a NaK auxiliary cooling loop. For redundancy, four units in parallel are used in the condenser and in the latter two loops. The reactor fuel is uranium mononitride (UN), and the cladding is a ductile tungsten alloy; the structural materials for the reactor and primary loop may be W or Ta alloys. In the power-conversion loop, Ta alloys are employed in the boiler and in the ducts and structures upstream of the turbine; Mo, Ta, and Nb alloys may be employed in the turbine; Nb-base and lower temperature materials are planned for components downstream of the turbine. Stainless steel tubes and armor are the probable materials for the radiator; clad copper conducting fins and vapor chamber (heat pipe) types of fins are receiving study. F.R.L.

A69-11394 #
MHD - WHERE AT AND WHERE TO?
Thomas R. Brogan.
Astronautics and Aeronautics, vol. 6, Nov. 1968, p. 48-53.
33 refs.

Discussion of the present state and future prospects of MHD technology. Possible MHD applications in industry are considered, and the performance and cost of the existing MHD generators are reviewed. MHD is viewed as a space-derived technology promising high profits and economic advantages but requiring large invest-

ment on a national scale. MHD principles, background information, and comments on work in the U.S., the USSR, the UK, France, and Japan are given. V.Z.

A69-11801 *

MATERIALS RESEARCH PROBLEMS IN THE DIRECT CONVERSION OF THERMAL RADIATIVE AND CHEMICAL ENERGY INTO ELECTRICITY.

Fritz Wald (Tyco Laboratories, Inc., Waltham, Mass.) and Martin Weinstein (Tyco Laboratories, Inc., Materials Science Dept., Waltham, Mass.).

SAMPE Journal, vol. 4, Oct.-Nov. 1968, p. 51-64. 64 refs. Contracts No. NAS 5-9149; No. N 00014-66-C-0147.

Discussion of the general mechanisms of electric energy production in the direct energy conversion methods of thermoelectricity, solar cells, thermionics, and fuel cells. Some of the materials limitations currently encountered in the use of devices based on these methods are pointed out. The advantage of a thermoelectric generator lies in its potential for long, unattended, and maintenance-free operation in severe environments. The thermionic converter uses two electrodes, separated and insulated from one another; heat is applied to one of the electrodes (typically 1400 to 2200 K), and electrons are boiled out into the intervening gap. These traverse the space between plates and are collected by the cooler anode (typically 600 to 1200 K). Part of the heat energy used to release the electrons is converted into useful voltage. The solar cell is, thermodynamically, a device which can convert radiant energy directly into electricity and therefore is not subject to the Carnot cycle limitation of a heat engine as are thermoelectric and thermionic devices. A fuel cell, as a battery, may be defined as a device which converts chemical energy directly into electrical energy. P.v.T.

A69-12425 #

A SHOCK TUBE STUDY OF NONEQUILIBRIUM MHD POWER GENERATION.

Yasuo Mori, Haruo Kawada (Tokyo Institute of Technology, Dept. of Mechanical Engineering, Tokyo, Japan), and Kazutake Imani.

JSME, Bulletin, vol. 11, Aug. 1968, p. 679-690. 25 refs.

Study of an inert-gas MHD generator utilizing nonequilibrium ionization under idealized working conditions achieved in shock-tube experiments. By preheating the whole low-pressure chamber of the shock tube, it was possible to seed a sufficient amount of potassium to the working gas and to realize the conditions required for MHD power generation. The first type of generator under study utilized the induced electric field, resulting from the interaction of gas flow and magnetic field, to obtain nonequilibrium ionization. Whereas the steady-flow experiments reported so far have not yielded high electrical conductivities predicted by the nonequilibrium theory, the results of the detailed measurements in the present device were very close to those predictions. Absence of appreciable boundary effects and flow instability in experiments of such short durations are suggested to be the causes of this effect. The unfavorable effect of small amounts of impurities on the generator performance is also demonstrated. A second type of nonequilibrium generator utilizing metastable nitrogen was similarly tested, and found to be a promising alternative. Z.W.

A69-14099

TWO-DIMENSIONAL ANALYSIS OF THE MHD GENERATOR, TAKING INTO ACCOUNT THE HALL EFFECT [ZWEIDIMENSIONALE UNTERSUCHUNGEN VON MHD-GENERATOREN UNTER BERÜCKSICHTIGUNG DES HALLEFFEKTS].

Helmut Bresgen (Innsbruck, Universität, Institut für theoretische Physik, Innsbruck, Austria).

(Österreichische Physikalische Gesellschaft, Herbsttagung, Innsbruck, Austria, 1967.)

Acta Physica Austriaca, vol. 27, Nov. 1968, p. 248-254. In German.

Development of a new method for studying the edge effect in MHD generators. The behavior of physical quantities in an ionized gas environment is determined by combining the Maxwell equation and the corresponding extended hydrodynamic equation. For weakly ionized gases with a low magnetic Reynolds number and a rather low electrical conductivity, the Maxwell equation can be applied without the extended hydrodynamic equation. Stated physically this means that the externally incident magnetic field is not distorted by the flow of the medium. B.H.

A69-14152

THERMODYNAMIC ANALYSIS OF A CLOSED CYCLE WITH A MHD-GENERATOR AND MHD-COMPRESSOR.

V. L. Iakimenko (Akademiia Nauk SSSR, Institut Atomnoi Energii, Moscow, USSR).

(Teplofizika Vysokikh Temperatur, vol. 6, Mar.-Apr. 1968, p. 306-314.)

High Temperature, vol. 6, Mar.-Apr. 1968, p. 295-301. 5 refs. Translation.

Determination of the effect of Joule losses in an MHD generator and an MHD compressor on the efficiency of a closed cycle of thermal-to-electric energy conversion, in which electrical conductivity is maintained by nonequilibrium ionization. The Faraday variant of an MHD channel is discussed, assuming a one-dimensional gas flow and a small magnetic Reynolds number. The Joule losses increase with pressure and reduce sharply the efficiency of the cycle. The parameters for which the cycle has a positive efficiency are determined. V.Z.

A69-14153

ELECTROGASDYNAMIC GENERATOR.

A. T. Belevtsev, Iu. S. Bortnikov, N. S. Lidorenko, G. F. Muchnik, and I. B. Rubashov.

(Teplofizika Vysokikh Temperatur, vol. 6, Mar.-Apr. 1968, p. 320-326.)

High Temperature, vol. 6, Mar.-Apr. 1968, p. 306-312. 6 refs. Translation.

Theoretical and experimental investigation of the operation of a device converting the potential or kinetic energy of a moving dielectric medium into electric power. A system of direct conversion of thermal energy into electric power is examined, and some preliminary experimental data are discussed. The analytical and experimental results indicate that the "electrogasdynamic generator" should be able to compete with other existing energy converters. V.P.

A69-14154

SPECIAL CHARACTERISTICS OF INSTALLATIONS WITH MAGNETOGASDYNAMIC CONVERTERS WORKING ON THE RANKINE CYCLE.

S. A. Mokrushin, R. V. Radchenko, V. G. Stepanov, and A. G. Sheinkman (Ural'skii Politekhnicheskii Institut, Sverdlovsk, USSR).

(Teplofizika Vysokikh Temperatur, vol. 6, Mar.-Apr. 1968, p. 327-332.)

High Temperature, vol. 6, Mar.-Apr. 1968, p. 313-318. 6 refs. Translation.

Comparative thermodynamic analysis of MHD generators employing the Brayton and Rankine cycles. It is shown that in the case of nonequilibrium ionization the Rankine cycle will convert at higher MHD-channel Mach numbers than the Brayton cycle. Working fluids particularly suited for use in the Rankine cycle are examined. V.P.

A69-14162

REDUCTION OF TEMPERATURE IN AN OPEN-CYCLE MGD POWER PLANT OWING TO INJECTED ADDITIVES.

I. L. Mostinskii and E. G. Smirnova (Akademiia Nauk SSSR, Nauchno-Issledovatel'skii Institut Vysokikh Temperatur, Moscow, USSR).

(Teplofizika Vysokikh Temperatur, vol. 6, Mar.-Apr. 1968, p. 363-365.)

High Temperature, vol. 6, Mar.-Apr. 1968, p. 355-357. Translation.

Investigation of the temperature drop in the combustion chamber of an open-cycle MHD power plant due to the addition of K_2CO_3 as a function of various parameters. The temperature drop is examined as a function of the initial temperature of the combustion products,

pressure in the combustion chamber, oxygen content in the air, the amount of additive introduced, and the technique by which the additive is introduced. Experimental data are tabulated for these dependences, using both dry K_2CO_3 and K_2CO_3 dissolved in water. No significant correlation was established between the temperature drop and the initial pressure in the chamber. T.M.

A69-16158 *#
STATUS OF PHOTOVOLTAIC POWER TECHNOLOGY.
Arvin Smith (NASA, Washington, D.C.).
American Society of Mechanical Engineers, Winter Annual Meeting and Energy Systems Exposition, New York, N.Y., Dec. 1-5, 1968, Paper 68-WA/Sol-1. 12 p. 76 refs.
Members, $0.75; nonmembers, $1.50.

Review of the status of photovoltaic power technology primarily from the viewpoint of current and future applications to the exploration and use of space. The photovoltaic-solar cell technology has shown steady improvement in reliability, increased efficiency, reduced cost, increased power per unit of hardware weight, and ability to withstand extremes of the space environment. New developments are underway to increase solar-cell and array size, to reduce stowage volume during boosting into orbit, and to improve resistance to space radiation and thermal cycling. Silicon-cell electrical contacts and interconnections, low-energy proton damage to small exposed cell areas, and instability of CdS thin-film solar cells are examples of problems receiving attention at this time. M.M.

A69-17905
MAGNETOHYDRODYNAMIC METHOD OF OBTAINING ELECTRICAL ENERGY [MAGNITOGIDRODINAMICHESKII METOD POLUCHENIIA ELEKTROENERGII].
Edited by V. A. Kirillin and A. E. Sheindlin.
Moscow, Izdatel'stvo Energiia, 1968. 480 p. In Russian.

CONTENTS:

FOREWORD [PREDISLOVIE]. V. Kirillin and A. Sheindlin, p. 3-6.

THEORY OF NONEQUILIBRIUM LOW-TEMPERATURE PLASMA [K TEORII NERAVNOVESNOI NIZKOTEMPERATURNOI PLAZMY]. L. M. Biberman, V. S. Vorob'ev, and I. T. Iakubov (Akademiia Nauk SSSR, Moscow, USSR), p. 209-263. 48 refs.

EXPERIMENTAL INVESTIGATION OF THE TRANSPORT PROPERTIES OF A PARTIALLY IONIZED PLASMA [EKSPERIMENTAL'NOE ISSLEDOVANIE TRANSPORTNYKH SVOISTV CHASTICHNO IONIZIROVANNOI PLAZMY]. E. I. Asinovskii, V. M. Batenin, V. A. Kirillin, and E. P. Pakhomov (Akademiia Nauk SSSR, Moscow, USSR), p. 263-273. 21 refs.

EXPERIMENTAL INVESTIGATION OF THE INFLUENCE OF THE COMBUSTION-PRODUCT COMPOSITION ON THE CONDUCTIVITY IN THE PRESENCE OF A POTASSIUM ADDITIVE [EKSPERIMENTAL'NOE ISSLEDOVANIE VLIIANIIA SOSTAVA PRODUKTOV SGORANIIA NA PROVODIMOST' PRI NALICHII DOBAVKI KALIIA]. S. A. Gol'denberg, E. P. Zimin, V. N. Ievlev, A. Ia. Korshunov, and V. A. Popov (Akademiia Nauk SSSR, Moscow, USSR), p. 273-280.

INVESTIGATION OF AN MHD-GENERATOR MODEL WITH AN ARGON-POTASSIUM PLASMA [ISSLEDOVANIE MODELI MGD-GENERATORA NA ARGONO-KALIEVOI PLAZME]. N. M. Maslennikov, V. N. Germaniuk, and M. A. Novgorodov (Vsesoiuznyi Elektrotekhnicheskii Institut, Moscow, USSR), p. 280-291. 8 refs.

STUDY OF AN ENERGY DISCHARGE SUSTAINED BY A LORENTZ FORCE [ISSLEDOVANIE ELEKTRICHESKOGO RAZRIADA, PODDERZHIVAEMOGO SILOI LORENTSA]. A. F. Vitshas and V. S. Golubev (Akademiia Nauk SSSR, Moscow, USSR), p. 292-303. 20 refs.

IONIZATION INSTABILITY IN A DISK CHANNEL OF A NONEQUILIBRIUM MHD GENERATOR [IONIZATSIONNAIA NEUSTOICHIVOST' V DISKOVOM KANALE NERAVNOVESNOGO MGD-GENERATORA]. I. Ia. Shipuk (Akademiia Nauk SSSR, Moscow, USSR), p. 308-314. 12 refs.

PARAMETERS OF MHD GENERATORS TAKING ACCOUNT OF THE IONIZATION INSTABILITY OF THE PLASMA [PARAMETRY MGD-GENERATOROV S UCHETOM IONIZATSIONNOI NEUSTOICHIVOSTI PLAZMY]. V. A. Gurashvili, Iu. A. Karëev, and A. V. Nedospasov (Akademiia Nauk SSSR, Moscow, USSR), p. 315-326. 12 refs.

CALCULATION OF MAGNETOHYDRODYNAMIC FLOWS IN THE CHANNELS OF MHD DEVICES [RASCHET MAGNITOGIDRODINAMICHESKIKH TECHENII V KANALAKH MGD-USTROISTV]. A. B. Vatazhin, G. A. Liubimov, and S. A. Regirer (Moskovskii Gosudarstvennyi Universitet, Moscow, USSR), p. 329-354. 46 refs.

APPROXIMATE SOLUTION OF THE EQUATIONS FOR THE BOUNDARY LAYER ON THE WALLS OF AN MHD GENERATOR [O PRIBLIZHENNOM RESHENII URAVNENII POGRANICHNOGO SLOIA NA STENKAKH MGD-GENERATORA]. L. I. Buznikova, B. G. Iotkovskii, and V. V. Kirillov (Akademiia Nauk SSSR, Moscow, USSR), p. 355-365. 7 refs.

UNSTEADY FLOW OF A CONDUCTING FLUID IN AN MHD GENERATOR CHANNEL, TAKING INTO ACCOUNT THE EXTERNAL CIRCUIT INDUCTANCE [NESTATSIONARNOE TECHENIE PROVODIASHCHEI ZHIDKOSTI V KANALE MGD-GENERATORA S UCHETOM INDUKTIVNOSTI VNESHNEI TSEPI]. A. I. Khozhainov (Akademiia Nauk SSSR, Moscow, USSR), p. 365-372. 5 refs.

OPTIMIZATION PROBLEM OF LINEAR CONDUCTION-TYPE MHD GENERATORS [PROBLEMA OPTIMIZATSII LINEINYKH KONDUKTSIONNYKH MGD-GENERATOROV]. V. I. Kovbasiuk, S. A. Medin, and A. E. Sheindlin (Akademiia Nauk SSSR, Moscow, USSR), p. 373-391. 20 refs.

VARIATIONAL PROBLEMS OF MAGNETOHYDRODYNAMICS [K VARIATSIONNYM ZADACHAM MAGNITNOI GIDRODINAMIKI]. A. N. Kraiko and F. A. Slobodkina, p. 392-417. 12 refs.

EXPERIMENTAL INVESTIGATION OF AN INJECTOR MODEL AS A VAPORIZER FOR MHD SYSTEMS [EKSPERIMENTAL'NOE ISSLEDOVANIE MODELI INZHEKTORA KAK RAZGONNOGO USTROISTVA DLIA MGD-USTANOVOK]. M. E. Deich, E. P. Markov, A. P. Sevast'ianov, G. V. Tsiklauri, E. E. Shpil'rain, and K. A. Iakimovich (Akademiia Nauk SSSR; Moskovskii Energeticheskii Institut, Moscow, USSR), p. 433-444. 9 refs.

DETERMINATION OF THE LOCAL PARAMETERS OF A FLOW IN THE MIXING CHAMBER OF A VAPORIZER [OPREDELENIE LOKAL'NYKH PARAMETROV POTOKA V KAMERE SMESHENIIA RAZGONNOGO USTROISTVA]. E. E. Shpil'rain, G. V. Tsiklauri, A. K. Rozental', and A. P. Sevast'ianov (Akademiia Nauk SSSR, Moscow, USSR), p. 444-456.

METHOD OF DESIGNING A SIMPLE INJECTOR [METODIKA RASCHETA PROSTEISHEGO INZHEKTORA]. M. E. Deich, V. F. Stepanchuk, G. V. Tsiklauri, and A. P. Sevast'ianov (Moskovskii Energeticheskii Institut; Akademiia Nauk SSSR, Moscow, USSR), p. 456-467.

ESTIMATION OF THE EFFICIENCY OF LIQUID-METAL MHD SYSTEMS WITH JUMPWISE OPERATION OF THE INJECTOR IN THE MIXING CHAMBER OF THE VAPORIZER [OTSENKA EFFEKTIVNOSTI ZHIDKOMETALLICHESKIKH MGD-USTANOVOK PRI RABOTE INZHEKTORA SO SKACHKOM V KAMERE SMESHENIIA RAZGONNOGO USTROISTVA]. V. F. Stepanchuk and G. V. Tsiklauri (Moskovskii Energeticheskii Institut, Moscow, USSR), p. 468-476.

A69-17909 #
INVESTIGATION OF AN MHD-GENERATOR MODEL WITH AN ARGON-POTASSIUM PLASMA [ISSLEDOVANIE MODELI MGD-GENERATORA NA ARGONO-KALIEVOI PLAZME].
N. M. Maslennikov, V. N. Germaniuk, and M. A. Novgorodov (Vsesoiuznyi Elektrotekhnicheskii Institut, Moscow, USSR).
IN: MAGNETOHYDRODYNAMIC METHOD OF OBTAINING ELECTRICAL ENERGY [MAGNITOGIDRODINAMICHESKII METOD POLUCHENIIA ELEKTROENERGII].
Edited by V. A. Kirillin and A. E. Sheindlin.
Moscow, Izdatel'stvo Energiia, 1968, p. 280-291. 8 refs. In Russian.

Measurement of the electrical conductivity of a potassium-

seeded argon plasma in an induced electric field at a static gas temperature in the range from 1300 to 1500 K and at a pressure of 0.04 atm in the flow. Experiments were conducted with two identical devices; one was used to study the effects near the electrodes, while the other served for optical observations. Current flows between the electrodes are examined, along with the cathode and anode voltage drops at the potassium-activated electrodes. Optical observations concern the effect of the plasmatron arc on the spectrum and conductivity of the plasma. T.M.

A69-18255
STUDIES OF THERMIONIC ENERGY CONVERTERS [UNTERSUCHUNGEN AN THERMIONISCHEN ENERGIEWANDLERN].
Willi Thielo (Deutsche Versuchsanstalt für Luft- und Raumfahrt, Institut für Energiewandlung und elektrische Antriebe, Stuttgart, West Germany).
DVL-Nachrichten, Jan. 1969, p. 409, 410. In German.
Review of research and development studies in the field of direct conversion of heat to electric power carried out in the Institut für Energiewandlung und elektrische Antriebe at Stuttgart. The theory and efficiency of thermionic energy converters are discussed. Design considerations aimed at improving the performance of these devices are mentioned. V.Z.

A69-20124
PROGRESS TOWARDS A NUCLEAR FUSION REACTOR.
J. B. Adams (United Kingdom Atomic Energy Authority, Atomic Energy Research Establishment, Harwell, Berks., England).
Contemporary Physics, vol. 10, Jan. 1969, p. 1-20. 42 refs.
Description of the physical conditions under which nuclear fusion reactions are most likely to be sustained, with emphasis on the sharp difference between the plasma state of matter necessary for nuclear fusion reactions and the thermodynamically more relaxed conditions sufficient for nuclear fission reactions. The confinement of hot dense plasmas by magnetic fields is the principal scientific problem to be solved, and progress in this work under the main headings of open-ended magnetic confinement systems and closed magnetic confinement systems is described. The technological problems of nuclear fusion reactors, which are the next major obstacle to be overcome once the confinement problem is solved are reviewed, and the economic possibilities of these reactors as electric power producers are examined. (Author)

A69-20871
DESIGN AND DIMENSIONING OF A NUCLEAR POWER SUPPLY INSTALLATION WITH AN IN-CORE THERMIONIC REACTOR [ZUR AUSLEGUNG UND BEMESSUNG EINER NUKLEAREN ENERGIEVERSORGUNGSANLAGE MIT INCORE-THERMIONIK-REAKTOR].
A. Quast and W. Rasch (Deutsche Forschungsanstalt für Luft- und Raumfahrt, Institut für Strahlantriebe, Institutsteil nichtkonventionelle Antriebe und Energetik, Braunschweig, West Germany).
DFL-Mitteilungen, Dec. 1968, p. 381-393. 23 refs. In German.
Description of the in-core thermionic reactor (ITR) envisioned as a common project of the BBC, Interatom, and Siemens, with the expectation that a terrestrial test reactor will be constructed within the next fifteen years. The theoretical basis of the reactor is treated, and a detailed analysis of its components is given. These include the cooling system, the radiator, the capacitive cooling, and the reactor shielding. The application of the ITR as a space power source, and for use in satellites for direct TV broadcasts, is discussed. B.H.

A69-21054
DIRECT ELECTROCHEMICAL CONVERSION OF THE ENERGY OF A RADIOACTIVE ELEMENT [CONVERSION ELECTROCHIMIQUE DIRECTE DE L'ENERGIE D'UN RADIOELEMENT].
C. Eyraud, J. Lenoir, and P. Jenin (Lyon, Université, Laboratoire de Génie Chimique, Lyon; Direction des Recherches et Moyens d'Essais, Paris, France).
IN: ELECTROCHEMICAL GENERATORS FOR SPACE APPLICATIONS; CENTRE NATIONAL D'ETUDES SPATIALES, INTERNATIONAL CONVENTION, PARIS, FRANCE, DECEMBER 4-7, 1967, PROCEEDINGS [LES GENERATEURS ELECTROCHIMIQUES POUR APPLICATIONS SPATIALES; CENTRE NATIONAL D'ETUDES SPATIALES, COLLOQUE INTERNATIONAL, PARIS, FRANCE, DECEMBER 4-7, 1967, PROCEEDINGS].
Paris, Dunod Editeur, 1968, p. 233-243. 6 refs. In French.
Description of two fuel cells using radioactive elements and working at room temperatures. The first fuel cell has a cathode and anode made of paper or textile covered by copper and nickel, respectively. Moreover, the anode is coated by an activated palladium coating. The electrolyte is a solution of potassium hydroxide or sodium silicate. The cell is powered by a mixture of hydrogen and oxygen obtained by water radiolysis. It is found that this fuel cell has a relatively short life. The second fuel cell, which is purely hypothetical, has a palladium-coated nickel foil anode and a copper or silver foil cathode. It is suggested that the water radiolysis in this cell be carried out inside the fuel cell by means of ^{210}Po or ^{60}Co. Z.W.

A69-21592 #
ANALYSIS OF A POWER SOURCE EMPLOYING AN MHD GENERATOR AND A THERMOCOMPRESSOR [ANALIZ SKHEMY ENERGETICHESKOI USTANOVKI S MGD-GENERATOROM I TERMOKOMPRESSOROM].
V. I. Kovbasiuk and S. A. Medin (Akademiia Nauk SSSR, Nauchno-Issledovatel'skii Institut Vysokikh Temperatur, Moscow, USSR).
Teplofizika Vysokikh Temperatur, vol. 6, Nov.-Dec. 1968, p. 1118-1123. 5 refs. In Russian.
Thermodynamic analysis of an electric power source employing an MHD generator in combination with a device in which injection of a coolant leads to an increase in total pressure in a high-velocity hot gas flow (thermocompressor). It is shown that such a thermodynamic cycle, in addition to possessing high efficiency, also increases the stability of the power source and makes it possible to obtain a high-temperature heat exchanger with constant pressure characteristics. The optimum operational conditions of the thermocompressor are determined, and the thermodynamic cycle studied is compared with a conventional Brayton cycle. V.P.

A69-22457
ANALYSIS OF AN OPTICAL MOTOR SYSTEM ENERGIZED WITH A LASER.
Robert H. Johnson, Alfred P. Szews, and T. Koryu Ishii (Marquette University, Dept. of Electrical Engineering, Milwaukee, Wis.).
IN: NATIONAL ELECTRONICS CONFERENCE, 24TH, CHICAGO, ILL., DECEMBER 9-11, 1968, PROCEEDINGS.
Conference sponsored by the Illinois Institute of Technology, the Institute of Electrical and Electronics Engineers, Northwestern University, and the University of Illinois.
Oak Brook, Ill., National Electronics Conference, Inc., 1968, p. 377-381.
Description of an optical motor that efficiently converts laser energy into mechanical rotational energy. Theoretical and experimental analysis of an optical motor system energized by a laser shows a peaking of speed at various distances from the laser. Conditions for a long-distance self-starting motor system are given. Theoretical equations, which were experimentally verified, for controlling the speed of the motor are described. The motor system employs silicon solar cells mounted on a rotor coil with three coils in a Y connection. A permanent magnet inside the coil is fixed to the motor mount. F.R.L.

A69-23095
THE OPTIMUM DYNAMIC REGIMES OF MGD ENERGY CONVERTERS.
O. E. Pushkarev.
(Magnitnaia Gidrodinamika, no. 1, 1966, p. 55-64.)
Magnetohydrodynamics, vol. 2, Jan.-Mar. 1966, p. 30-35. 9 refs. Translation.

Application of the one-dimensional equations for the channel flow of a conducting gas to the investigation of the optimum modes of operation of an MGD converter, in the case of constant local electric efficiency and magnetic field inductance. The applicability range of the one-dimensional approximation to the electric and magnetic quantities is established. Optimality conditions are derived for which the system of MHD equations for an MGD converter can be written in closed form. Analytical solutions of several practical problems are obtained which provide qualitative estimates of converter operation. V.P.

A69-23102
AN O-SHAPED UNSATURATED MAGNETIC SYSTEM WITH TWO EXCITATION COILS DESIGNED FOR MHD-MACHINERY.
P. V. Kachanov.
(Magnitnaia Gidrodinamika, no. 1, 1966, p. 142-145.)
Magnetohydrodynamics, vol. 2, Jan.-Mar. 1966, p. 85, 86. Translation.
Magnitnaia Gidrodinamika, no. 1, 1966, p. 142-145. In Russian.

Discussion of O-shaped magnetic systems which use an unsaturated steel magnetic circuit to produce strong uniform magnetic fields. It is shown that in the case of a uniform distribution of the current sheet over the perimeter of a channel of square cross section, a strong magnetic field can be obtained provided the magnetic circuit remains unsaturated. V.P.

A69-23441 #
ELECTROPHYSICAL AND RADIATIVE PROPERTIES OF A NON-EQUILIBRIUM ARGON-POTASSIUM PLASMA AS A POSSIBLE WORKING FLUID FOR AN MHD GENERATOR [ELEKTROFIZICHESKIE I RADIATSIONNYE SVOISTVA NERAVNOVESNOI ARGON-KALIEVOI PLAZMY-VOZMOZHNOGO RABOCHEGO TELA MGD-GENERATORA].
V. G. Andropov, E. I. Asinovskii, V. M. Batenin, G. S. Lopatskii, and V. F. Chinnov (Akademiia Nauk SSSR, Nauchno-Issledovatel'skii Institut Vysokikh Temperatur, Moscow, USSR).
IN: ELECTRICITY FROM MHD; INTERNATIONAL ATOMIC ENERGY AGENCY, SYMPOSIUM ON MAGNETOHYDRODYNAMIC ELECTRICAL POWER GENERATION, WARSAW, POLAND, JULY 24-30, 1968, PROCEEDINGS. VOLUME 1 - CLOSED-CYCLE MHD WITH GASEOUS WORKING FLUIDS (Sections 1-a to 1-g).
Vienna, International Atomic Energy Agency, 1968, p. 117-144.
25 refs. In Russian.

Experimental investigation of the influence of emission and of an external magnetic field on the nonequilibrium electrical conductivity of an argon-potassium plasma. To this end, the resonance radiation from an optically inhomogeneous finite plasma volume is studied, together with the influence of radiation on the establishment of partially local thermodynamic equilibrium. The experimental results obtained for the diffusion of resonance radiation and for the electron energy losses due to elastic collisions are used to identify the nature of the energy redistribution between the particles and photons as they approach the plasma boundary. It is shown that resonance radiation can contribute as much as 30% to the local energy balance. An investigation of the effective electrical conductivity of a nonequilibrium plasma in a transverse magnetic field under conditions encountered in an MHD generator shows that both acoustic and ionization instabilities can arise in such a plasma even when the value of the Hall parameter is on the order of unity. V.P.

A69-23450 #
INVESTIGATION OF ARGON DISCHARGES WITH METAL CAPILLARY CATHODES.
G. Hahn and M. Salvat (Institut für Plasmaphysik GmbH, Garching, West Germany).
IN: ELECTRICITY FROM MHD; INTERNATIONAL ATOMIC ENERGY AGENCY, SYMPOSIUM ON MAGNETOHYDRODYNAMIC ELECTRICAL POWER GENERATION, WARSAW, POLAND, JULY 24-30, 1968, PROCEEDINGS. VOLUME 1 - CLOSED-CYCLE MHD WITH GASEOUS WORKING FLUIDS (Sections 1-a to 1-g).
Vienna, International Atomic Energy Agency, 1968, p. 331-342.
7 refs.
EURATOM-supported research.

Investigation of argon discharges in order to explore the possibility of using pure rare gases as the working medium in MHD generators. In pure inert gas generators the electrons have to be produced at the channel entrance by preionization at the gas temperatures involved (about 1500 K). The current-voltage characteristic of such a discharge is largely governed by the number of electrons on the upstream side of the discharge gap, the flow velocity, electrode phenomena, and the gas temperature. A system was assembled in which the factors listed could be investigated, using argon as the gas. Investigations were conducted in static gas and in streaming gas. G.R.

A69-23454 #
METHODS OF DETERMINING INDUCED MAGNETIC FIELDS IN LINEAR DC MHD GENERATORS [METODY OPREDELENIIA INDUTSIROVANNYKH MAGNITNYKH POLEI V LINEINYKH MGD-GENERATORAKH POSTOIANNOGO TOKA].
A. I. Bertinov, D. A. But, and V. I. Chitechian (Moskovskii Aviatsionnyi Institut, Moscow, USSR).
IN: ELECTRICITY FROM MHD; INTERNATIONAL ATOMIC ENERGY AGENCY, SYMPOSIUM ON MAGNETOHYDRODYNAMIC ELECTRICAL POWER GENERATION, WARSAW, POLAND, JULY 24-30, 1968, PROCEEDINGS. VOLUME 1 - CLOSED-CYCLE MHD WITH GASEOUS WORKING FLUIDS (Sections 1-a to 1-g).
Vienna, International Atomic Energy Agency, 1968, p. 463-485.
10 refs. In Russian.

Description of two methods of estimating the effect of the intrinsic field of the channel of a linear dc MHD generator on the characteristics of the generator. Channels with ferromagnetic walls and nonmagnetic walls are considered. Equations are derived for determining the distortion of the electromagnetic field by a traveling conducting medium in channels with ferromagnetic walls. A Fredholm equation of the second kind with two independent variables is used for determining the two-dimensional intrinsic field in channels bounded by nonmagnetic walls. V.Z.

A69-23457 #
EXPERIMENTAL INVESTIGATION OF INSTABILITIES IN A POTASSIUM-SEEDED ARGON PLASMA IN CROSSED ELECTRIC AND MAGNETIC FIELDS.
W. Riedmüller (Institut für Plasmaphysik GmbH, Garching, West Germany).
IN: ELECTRICITY FROM MHD; INTERNATIONAL ATOMIC ENERGY AGENCY, SYMPOSIUM ON MAGNETOHYDRODYNAMIC ELECTRICAL POWER GENERATION, WARSAW, POLAND, JULY 24-30, 1968, PROCEEDINGS. VOLUME 1 - CLOSED-CYCLE MHD WITH GASEOUS WORKING FLUIDS (Sections 1-a to 1-g).
Vienna, International Atomic Energy Agency, 1968, p. 519-528.
6 refs.
EURATOM-supported research.

Investigation of the degree of impairment instabilities may cause in the characteristics of MHD generators operating on alkali-seeded noble gases with nonequilibrium ionization. Results of detailed investigations on the onset and amplitudes of fluctuations in a streaming argon-potassium plasma in crossed electric and magnetic fields are presented. The experiments are performed at atmospheric pressure, gas temperatures up to 2000 K, and gas velocities up to 500 m/sec. An experimental device which was used to separate the losses caused by instabilities from others, such as wall effects, is described. The results of time-resolved and simultaneously performed electric field strength, electron temperature, and electron density measurements are presented. These quantities are measured as functions of the magnetic field strength, current density, electron temperature elevation, gas temperature, and gas velocity. From these measurements it is possible to derive the amplitudes and the phase relations between the various quantities, as well as the velocity and direction of the disturbances. M.M.

A69-23458 #
CESIUM-DOPED MERCURY AS A WORKING FLUID FOR STUDYING THE SPECIFIC FEATURES OF MHD GENERATORS BASED ON A

RANKINE CYCLE [RTUT' S TSEZIEM KAK RABOCHEE VESHCHESTVO DLIA IZUCHENIIA OSOBENNOSTEI MGD-GENERATOROV, RABOTAIUSHCHIKH NA TSIKLE RENKINA].
Iu. A. Kareev, V. T. Karpukhin, and A. V. Nedospasov (Akademiia Nauk SSSR, Institut Atomnoi Energii, Moscow, USSR).
IN: ELECTRICITY FROM MHD; INTERNATIONAL ATOMIC ENERGY AGENCY, SYMPOSIUM ON MAGNETOHYDRODYNAMIC ELECTRICAL POWER GENERATION, WARSAW, POLAND, JULY 24-30, 1968, PROCEEDINGS. VOLUME 1 - CLOSED-CYCLE MHD WITH GASEOUS WORKING FLUIDS (Sections 1-a to 1-g).

Vienna, International Atomic Energy Agency, 1968, p. 547-568.
8 refs. In Russian.

Results of an experimental and theoretical study of the characteristics of a mercury-cesium plasma in crossed electric and magnetic fields. The study is aimed at determining the performance of such plasmas as the working fluids of MHD generators using Rankine metal-vapor cycles. The maximum ratio between the Hall field and the longitudinal field attainable with such plasmas is found to be about two. Efficiencies ranging from 5 to 20%, depending on the parameters of the Rankine cycle, are obtained for Faraday-type MHD generators using nonequilibrium mercury-cesium plasmas. It is contended that the turbulent state of such plasmas does not preclude an effective energy conversion in such MHD generators. V. Z.

A69-23460 #
EFFECTIVE CONDUCTIVITY OF AN MHD PLASMA IN A TURBULENT STATE.
V. Zampaglione (Comitato Nazionale per l'Energia Nucleare, Laboratorio Conversione Diretta, Frascati, Italy).
IN: ELECTRICITY FROM MHD; INTERNATIONAL ATOMIC ENERGY AGENCY, SYMPOSIUM ON MAGNETOHYDRODYNAMIC ELECTRICAL POWER GENERATION, WARSAW, POLAND, JULY 24-30, 1968, PROCEEDINGS. VOLUME 1 - CLOSED-CYCLE MHD WITH GASEOUS WORKING FLUIDS (Sections 1-a to 1-g).

Vienna, International Atomic Energy Agency, 1968, p. 593-604.

Extension of Velikhov and Dykhne's nonlinear theory of plasma turbulence due to ionization instability (1963) to the range of values of the Hall parameter where it can be applied - namely, near the stability limit - including gas temperature effects, for the case of an MHD generator with constant load coefficients. A closed set of implicit equations is obtained for the basic averaged parameters of the plasma in the turbulent state, and these equations are then solved for values of the driving parameters corresponding to typical conditions of an MHD experiment. For large values of the Hall parameter, a theory is developed under the assumption of isotropic turbulence. Comparisons of the two theories with experimental data are discussed. M. M.

A69-23463 #
STUDY OF THE ELECTRICAL CONDUCTIVITY OF THE PLASMA IN COAXIAL-TYPE MHD GENERATOR MODELS [ISSLEDOVANIE ELEKTROPROVODNOSTI PLAZMY V MODELIAKH MGD-GENERATOROV KOAKSIAL'NOGO TIPA].
M. I. Afanas'ev, V. V. Pirogovskii, Iu. T. Puzynovich, I. I. Sabanskii, A. M. Stolov, and A. D. Frolov (Nauchno-Issledovatel'skii Institut Elektrofizicheskoi Apparatury, Leningrad, USSR).
IN: ELECTRICITY FROM MHD; INTERNATIONAL ATOMIC ENERGY AGENCY, SYMPOSIUM ON MAGNETOHYDRODYNAMIC ELECTRICAL POWER GENERATION, WARSAW, POLAND, JULY 24-30, 1968, PROCEEDINGS. VOLUME 1 - CLOSED-CYCLE MHD WITH GASEOUS WORKING FLUIDS (Sections 1-a to 1-g).

Vienna, International Atomic Energy Agency, 1968, p. 643-662.
10 refs. In Russian.

Investigation of the electrical conductivity and electron temperature in a coaxial experimental MHD generator with a steady annular magnetic field, using inert gases with alkali metal additions as the working fluids. The effect of the Joule heating of the plasma electron component by induced or applied electric fields on the performance of these MHD generators is studied. The results are in satisfactory agreement with available experimental results. V. Z.

A69-23471 #
THE M. I. T. NON-EQUILIBRIUM MHD GENERATOR.
J. L. Kerrebrock and M. A. Hoffman (Massachusetts Institute of Technology, Cambridge, Mass.).
IN: ELECTRICITY FROM MHD; INTERNATIONAL ATOMIC ENERGY AGENCY, SYMPOSIUM ON MAGNETOHYDRODYNAMIC ELECTRICAL POWER GENERATION, WARSAW, POLAND, JULY 24-30, 1968, PROCEEDINGS. VOLUME 2 - CLOSED-CYCLE MHD WITH GASEOUS WORKING FLUIDS (Sections 1-h to 1-k).

Vienna, International Atomic Energy Agency, 1968, p. 789-805.
11 refs.
Contract No. AF 33(615)-67-C-1148.

Experimental investigation of the behavior of a linear nonequilibrium MHD generator, operating at $M = 2$, at a Hall parameter of three (or more), and using cesium-seeded helium as the working fluid. The generator is large enough to minimize viscous effects and permits large nonequilibrium effects. The tests were performed with several generator configurations with hot and cold insulator walls, with and without preionization, and in both Faraday and Hall connections. It proved possible to obtain electron temperatures as high as 2700 K but only near short circuit, because the Hall voltage was never more than a fraction of its ideal value. Preionization was found to be a necessary factor. Several loss mechanisms are proposed to explain the low Hall fields observed. These include electrothermal instabilities, electrode wall shorting, insulator wall boundary layer shorting, and end losses. It was found that behavior near open circuit could be controlled using cold insulator walls and a combination of electrode wall shorting and end losses, while insulator boundary layer shorting appeared to be advantageous in the case of hot insulator walls. Means of preventing these shorts are examined. V. P.

A69-23473 #
HIGH HALL COEFFICIENT EXPERIMENTS IN A LARGE DISC GENERATOR.
J. F. Louis (Avco Corp., Avco-Everett Research Laboratory, Everett, Mass.).
IN: ELECTRICITY FROM MHD; INTERNATIONAL ATOMIC ENERGY AGENCY, SYMPOSIUM ON MAGNETOHYDRODYNAMIC ELECTRICAL POWER GENERATION, WARSAW, POLAND, JULY 24-30, 1968, PROCEEDINGS. VOLUME 2 - CLOSED-CYCLE MHD WITH GASEOUS WORKING FLUIDS (Sections 1-h to 1-k).

Vienna, International Atomic Energy Agency, 1968, p. 825-849.
Contract No. AF 33(615)-3413.

Experimental investigation of the plasma properties and fluid mechanics of a large disk generator driven by argon or molecular gases seeded with cesium. In seeded argon, large amounts of nonequilibrium ionization were found to exist but were accompanied by large electron density fluctuations. A value of two was obtained for the maximum effective Hall coefficient, which agrees with the theoretical expectations for a plasma with pronounced isotropic fluctuations. The generator performance and the plasma properties are compared for geometrically different preionization discharges. A preionization discharge brings the degree of seed ionization close to a value of one upstream of the generator inlet and eliminates the relaxation and inlet losses; however, electron density fluctuations associated with nonequilibrium ionization still exist. V. P.

A69-23475 #
EXPERIMENTAL RESULTS OF MHD CONVERSION USING A RARE GAS [RESULTATS D'EXPERIENCES DE CONVERSION MHD A GAZ RARE].
R. Bertrand, J. C. Coche, J. P. Jacquemin, J. Le Bronec, C. Vavasseur, and P. Zettwoog (Commissariat à l'Energie Atomique, Centre d'Etudes Nucléaires de Saclay, Gif-sur-Yvette, Essonne, France).
IN: ELECTRICITY FROM MHD; INTERNATIONAL ATOMIC ENERGY AGENCY, SYMPOSIUM ON MAGNETOHYDRODYNAMIC ELECTRICAL POWER GENERATION, WARSAW, POLAND, JULY 24-30, 1968, PROCEEDINGS. VOLUME 2 - CLOSED-CYCLE MHD WITH GASEOUS WORKING FLUIDS (Sections 1-h to 1-k).

Vienna, International Atomic Energy Agency, 1968, p. 873-880.
In French.

Discussion of the experiments carried out on the Typhee loop and a tentative interpretation of results. An MHD region is selected in which the one-dimensional theory without electron heating represents the zero-order approximation. A theoretical description of the actual duct is obtained by introducing a certain number of correction effects. For each of these effects the measures to be taken to eliminate the correction or to reduce it to a low order of magnitude are considered. It is shown that, from this point of view, heating of the electrons is not particularly desirable. An attempt is made to reduce the discrepancies between theory and experimental results by improving the accuracy of the measuring devices. Z.W.

A69-23479 #
CLOSED-CYCLE MPD EXPERIMENTS WITH APPLIED ELECTRIC AND MAGNETIC FIELDS.
I. R. McNab, R. Brown (International Research and Development Co., Ltd., Newcastle-upon-Tyne, England), and M. G. Haines (London, University, Imperial College of Science and Technology, Physics Dept., London, England).
IN: ELECTRICITY FROM MHD; INTERNATIONAL ATOMIC ENERGY AGENCY, SYMPOSIUM ON MAGNETOHYDRODYNAMIC ELECTRICAL POWER GENERATION, WARSAW, POLAND, JULY 24-30, 1968, PROCEEDINGS. VOLUME 2 - CLOSED-CYCLE MHD WITH GASEOUS WORKING FLUIDS (Sections 1-h to 1-k).

Vienna, International Atomic Energy Agency, 1968, p. 925-938. 17 refs.
Research supported by C. A. Parsons and Co., the International Research and Development Co., and AEC.
Description of experiments performed in a closed-cycle MPD facility with applied electric and magnetic fields. During experiments using applied magnetic fields, the performance of linear segmented electrode generators was found to be less than ideal. The Faraday open circuit voltage, plasma conductivity, and Hall voltage were lower than predicted by theory, and increasing the magnetic field strength increased the discrepancy between theory and experiment. The major factors affecting generator performance were current leakage through the insulator, finite segmentation effects, inlet ionization and recombination relaxation effects, and plasma nonuniformities. Current leakage was the major influence on the Faraday open-circuit voltage, and good agreement with theory was obtained for generators operating under different conditions. Plasma nonuniformities, arising from inadequate mixing of the cesium seed with the main helium flow and the laminar flow in the small cross-section generators, and finite segmentation effects were primarily responsible for the reduction in conductivity and Hall voltage. Inlet-relaxation calculations showed that no magnetically induced ionization should be expected, as was observed, and that the generator free-stream conductivity should be frozen near the stagnation value. The frozen conductivity was used to correlate the experimental results with theories relating to nonideal generator behavior. M.M.

A69-23480 #
EXPERIMENTAL STUDY OF AN MHD GENERATOR MODEL WITH A NONEQUILIBRIUM PLASMA [EKSPERIMENTAL'NOE ISSLEDOVANIE MODELI MGD-GENERATORA S NERAVNOVESNOI PLAZMOI].
N. M. Maslennikov, V. N. Germaniuk, and M. A. Novgorodov (Vsesoiuznyi Elektrotekhnicheskii Institut, Moscow, USSR).
IN: ELECTRICITY FROM MHD; INTERNATIONAL ATOMIC ENERGY AGENCY, SYMPOSIUM ON MAGNETOHYDRODYNAMIC ELECTRICAL POWER GENERATION, WARSAW, POLAND, JULY 24-30, 1968, PROCEEDINGS. VOLUME 2 - CLOSED-CYCLE MHD WITH GASEOUS WORKING FLUIDS (Sections 1-h to 1-k).

Vienna, International Atomic Energy Agency, 1968, p. 939-955. 6 refs. In Russian.
Discussion of the performance of an experimental MHD generator operating on a nonequilibrium argon plasma with potassium additions in the presence of an induced electric field or an external electric field. Experiments with a single tantalum cathode and a single copper anode and with ten pairs of such electrodes are carried out on the generator model. The highest emissivity of a potassium-activated tantalum cathode is established at a pressure of 0.25 atm, at cathode temperatures from 1400 to 1600 K. Spectral measurements show that the residual ionization in the plasmatron and the electron heating in the electric field of the generator are responsible for the instability of the argon plasma. V.Z.

A69-23483 #
DESIGN AND OPERATION OF AN EXPERIMENTAL CLOSED-LOOP MAGNETOPLASMADYNAMIC ENERGY CONVERSION SYSTEM.
E. Talaat (Maryland, University, Dept. of Mechanical Engineering, College Park, Md.).
IN: ELECTRICITY FROM MHD; INTERNATIONAL ATOMIC ENERGY AGENCY, SYMPOSIUM ON MAGNETOHYDRODYNAMIC ELECTRICAL POWER GENERATION, WARSAW, POLAND, JULY 24-30, 1968, PROCEEDINGS. VOLUME 2 - CLOSED-CYCLE MHD WITH GASEOUS WORKING FLUIDS (Sections 1-h to 1-k).

Vienna, International Atomic Energy Agency, 1968, p. 1017-1040. 16 refs.
Description of an experimental closed-loop MPD energy conversion system recently completed at the University of Maryland. This system is capable (1) of steady-state operation, (2) of circulating 4 mole/sec of any inert gas (or any mixture of inert gases), (3) of injecting up to about 0.04 mole/sec of caesium vapor, (4) of cyclically heating the mixture up to about 1500 K and cooling it down to temperatures within about 25 K above the environmental water temperatures, and (5) of separating the caesium as liquid for reevaporation and reinjection. The system was developed for the purpose of experimentally investigating the problems of usefully operating, in the nonequilibrium or auxiliary ionization mode, an MPD energy conversion duct with inert gases seeded (or unseeded) with caesium vapor, at gas temperatures up to 1500 K. Z.W.

A69-23484 #
AN IMPULSE INDUCTION MHD GENERATOR HAVING A MAGNETIC FIELD WITH A RADIAL COMPONENT.
J. Lego (Vysoká Škola Technická, Prague, Czechoslovakia).
IN: ELECTRICITY FROM MHD; INTERNATIONAL ATOMIC ENERGY AGENCY, SYMPOSIUM ON MAGNETOHYDRODYNAMIC ELECTRICAL POWER GENERATION, WARSAW, POLAND, JULY 24-30, 1968, PROCEEDINGS. VOLUME 2 - CLOSED-CYCLE MHD WITH GASEOUS WORKING FLUIDS (Sections 1-h to 1-k).

Vienna, International Atomic Energy Agency, 1968, p. 1043-1059.
Theoretical and experimental investigation of an impulse induction MHD generator with a cylindrical channel. Given certain assumptions, it is possible to write the general system of partial differential equations, which describes the behavior of the generator. The mean spatial values of the physical quantities are calculated under certain simplifying conditions, and a system of ordinary differential equations is obtained. After separation, the ordinary third-order differential equations for the velocity and current are found. These equations are homogeneous with constant and identical coefficients. The solution of these equations is not too complicated, and information about their time dependence is obtained. The expressions for the power generated and generator efficiency are found in the usual way, and an equation is obtained for the volt-ampere characteristic, while the characteristic of the generator is found not to be, in general, linear. The equations for the case of open-circuit current and short-circuit voltage are derived. They are the ordinary second-order differential equations, and their solutions give the possibility of determining two of the parameters of the plasma clusters. The theoretical conclusions are verified experimentally. M.M.

A69-23487 #
EXPERIMENTS ON A STRIATED-FLOW INDUCTION SYNCHRONOUS MHD GENERATOR.
J. Milewski, J. Stanco, and J. Samulski (Polska Akademia Nauk, Instytut Maszyn Przepływowych, Gdańsk, Poland).
IN: ELECTRICITY FROM MHD; INTERNATIONAL ATOMIC ENERGY AGENCY, SYMPOSIUM ON MAGNETOHYDRODYNAMIC ELECTRICAL POWER GENERATION, WARSAW, POLAND, JULY 24-30,

1968, PROCEEDINGS. VOLUME 2 - CLOSED-CYCLE MHD WITH GASEOUS WORKING FLUIDS (Sections 1-h to 1-k).

Vienna, International Atomic Energy Agency, 1968, p. 1097-1106. 6 refs.

Description of a method for producing a striated-flow in an induction synchronous MHD generator by nonthermal ionization of an inert seeded gas in the internal induced electric field of the generator. An experimental device is described in which an un-ionized gas (argon with a seed) at low pressure flows in an axial direction through an annular duct in which an alternating circumferential electric field is present. A stream of constricted ring discharges flowing with the gas is obtained, the discharges being initiated at the duct inlet by a rf ignition coil. The pressure of the gas was about 40 torr, the temperature was about 600 K, and the electric field intensity was about 2 V/cm peak. As a second step, the MHD generator itself was investigated. The experimental device was modified by removing the ac source and applying a dc radial magnetic field of sinusoidal distribution along the duct. A circumferential electric field resulted from the gas motion across the applied magnetic field. M.G.

A69-23490 #

EXPERIMENTAL WORK ON INDUCTIVE MAGNETOPLASMADYNAMIC CONVERTERS.

W. Peschka, W. Seeger, and H. Eitel (Deutsche Versuchsanstalt für Luft- und Raumfahrt, Institut für Energiewandlung und elektrische Antriebe, Stuttgart, West Germany).

IN: ELECTRICITY FROM MHD; INTERNATIONAL ATOMIC ENERGY AGENCY, SYMPOSIUM ON MAGNETOHYDRODYNAMIC ELECTRICAL POWER GENERATION, WARSAW, POLAND, JULY 24-30, 1968, PROCEEDINGS. VOLUME 2 - CLOSED-CYCLE MHD WITH GASEOUS WORKING FLUIDS (Sections 1-h to 1-k).

Vienna, International Atomic Energy Agency, 1968, p. 1151-1160.

In the paper an experimental arrangement is described which consists of a closed-cycle system, an ionization duct and an inductive MPD converter with a traveling wave component. Mercury has been used as the working medium; later it is proposed to use favorable noble gases. Ionization is effected by means of rf excitation. Some theoretical and experimental results are given. (Author)

A69-23491 #

EXPERIMENTAL AND THEORETICAL STUDIES OF GASEOUS SUSPENSIONS OF THERMIONIC EMITTING PARTICLES FOR USE AS MHD WORKING FLUIDS.

B. Waldie and I. Fells (Newcastle-upon-Tyne, University, Dept. of Chemical Engineering, Newcastle-upon-Tyne, England).

IN: ELECTRICITY FROM MHD; INTERNATIONAL ATOMIC ENERGY AGENCY, SYMPOSIUM ON MAGNETOHYDRODYNAMIC ELECTRICAL POWER GENERATION, WARSAW, POLAND, JULY 24-30, 1968, PROCEEDINGS. VOLUME 2 - CLOSED-CYCLE MHD WITH GASEOUS WORKING FLUIDS (Sections 1-h to 1-k).

Vienna, International Atomic Energy Agency, 1968, p. 1161-1172. 16 refs.

Research supported by the Science Research Council and the United Kingdom Atomic Energy Authority.

Results of experimental and theoretical studies aimed at assessing whether suspensions of thermionic emitting particles would be suitable as working fluids in large-scale MHD electrical power generators. The studies are mainly concerned with coagulation in suspensions of submicron barium oxide particles in argon, but the results are relevant to other suspensions. It is shown that the most successful technique for making suspensions of submicron barium oxide particles in argon involves the reaction of barium vapor with oxygen in an argon stream in an alumina tube reactor at about 1600 K. The suspensions were found to be polydisperse with log-normal size distributions and mass mean particle diameters generally in the range from 0.15 to 0.33 μ. The rates of coagulation in these barium oxide/argon suspensions are obtained from the rate of increase of the mass mean particle diameters when the suspensions were passed through tubes at various temperatures. It is concluded that because of coagulation, suspensions of solid thermionic emitting particles can only be considered as working fluids if the particle concentrations can be reduced markedly below those required theoretically for barium oxide/argon suspensions. M.G.

A69-24469

M.H.D. RESEARCH - PRESENT AND FUTURE.

M. W. Thring (Sheffield, University, Sheffield, England) and Vincent Joseph Ibberson (London, University, Queen Mary College, London, England).

The Engineer, vol. 227, Mar. 28, 1969, p. 474-477. 17 refs.

Discussion of the status of present MHD research in England and abroad and of likely trends it will take in the future. It is pointed out that MHD has been proved practicable for power generation, although the engineering has not yet been extrapolated to long-duration plants. No insurmountable difficulties are foreseeable in this respect, as materials and operating conditions are simultaneously improved. In spite of a lack of reliable calculations and comparisons with nuclear power-generation costs, the indications are that one or more of the more sophisticated ideas discussed would increase the predicted efficiency to make further development worthwhile. M.M.

A69-25214

CALCULATION MODEL FOR HALL TYPE ELECTROMAGNETIC PLASMA ACCELERATORS [EIN RECHENMODELL FÜR ELEKTROMAGNETISCHE PLASMABESCHLEUNIGER VOM HALL-TYP].

W. Oldekop (Deutsche Forschungsanstalt für Luft- und Raumfahrt, Braunschweig, West Germany) and H. J. Junge.

Luftfahrttechnik Raumfahrttechnik, vol. 15, Feb. 1969, p. 38-43. 6 refs. In German.

Investigation of the borderline case of a Hall accelerator, in which the thrust is affected only by the Lorentz forces in an external magnetic field. Experimental results obtained for an MPD accelerator are verified with a calculation model developed for a pure Hall accelerator. Although the calculation model is highly simplified, results showed good agreement with theoretical and experimental findings. The model is considered suitable for drawing conclusions on the acceleration mechanism in MPD acceleration. B.H.

A69-25359

CURRENT DISTRIBUTION AROUND A NORMAL SHOCK IN AN MHD DUCT.

John B. Heywood (Central Electricity Generating Board, Research Laboratories, Leatherhead, Surrey, England).

Plasma Physics, vol. 11, Apr. 1969, p. 259-270. 13 refs.

The two-dimensional current and voltage distribution around a normal shock wave in an MHD duct is analyzed using a conformal transformation. Both continuous electrode, and infinitely segmented electrode boundary conditions are considered. It is shown that on the anode wall for continuous electrodes, infinite current concentrations occur at the shock; for segmented electrodes, the electric field becomes infinite at this point. The dissipation is computed for this latter case and is shown to be 1/6-th of the one-dimensional dissipation over a comparable volume. It is concluded that these current and field concentrations could cause electrode and insulator damage and that a theoretical analysis of a flow with a normal shock should make some allowance for two-dimensional effects. (Author)

A69-25397

TWO-DIMENSIONAL CURRENT DISTRIBUTIONS IN FARADAY TYPE MHD ENERGY CONVERTERS OPERATING IN THE NON-EQUILIBRIUM CONDUCTION MODE.

Lajos L. Lengyel (Institut für Plasmaphysik GmbH, Garching, West Germany).

Energy Conversion, vol. 9, Mar. 1969, p. 13-23. 28 refs.

EURATOM-supported research.

Consideration of current and potential distributions in the plane normal to an applied magnetic field. Allowance is made for non-uniform gas temperature and velocity distributions, gasdynamic convection, nonequilibrium ionization and finite-rate relaxation

processes. Quantitative data are provided concerning the magnitude of these effects on the performance characteristics of MHD energy converters. Eddy currents induced in the plane normal to the flow direction are considered under open-circuit conditions. It is shown that the effective open-circuit voltage may be higher or lower than the value based on the average flow velocity/constant conductivity approximation, depending upon the plasma parameter distributions in the insulator wall boundary layers. B.H.

A69-25399
INDUCTION PHENOMENA IN MHD CONVERTERS WITH CONSTANT AND TRAVELLING MAGNETIC FIELD.
H. Weh, G. Waltke, and P. Appun (Braunschweig, Technische Hochschule, Institut für elektrische Maschinen, Braunschweig, West Germany).
Energy Conversion, vol. 9, Mar. 1969, p. 31-38. 15 refs.
Investigation of the influence of finite length and width on the operation characteristics of dc and ac MHD converters. Various mathematical methods for calculating the eddy currents caused by the finite dimensions of the converter are demonstrated. The much-used method of conformal mapping is limited to calculations of the time-invariant current distribution of dc converters. Flux-density distributions for ac and dc converters, and current loci, power output, and efficiency for ac converters are calculated. Numerical results are presented for liquid-metal and plasma dc converters. B.H.

A69-25862
DEUTSCHE GESELLSCHAFT FÜR FLUGWISSENSCHAFTEN, LECTURES ON ASTRONAUTICS, 7TH, TECHNISCHE UNIVERSITÄT BRAUNSCHWEIG, BRAUNSCHWEIG, WEST GERMANY, OCTOBER 7-11, 1968, PROCEEDINGS. VOLUME 2 - ENERGY SOURCES [DEUTSCHE GESELLSCHAFT FÜR FLUGWISSENSCHAFTEN, LEHRGANG FÜR RAUMFAHRTTECHNIK, 7TH, TECHNISCHE UNIVERSITÄT BRAUNSCHWEIG, BRAUNSCHWEIG, WEST GERMANY, OCTOBER 7-11, 1968, PROCEEDINGS. VOLUME 2 - ENERGIEQUELLEN].
Lectures supported by the Bundesministerium für Wissenschaftliche Forschung.
Bonn, Deutsche Gesellschaft für Flugwissenschaften, 1968. 291 p. In German.

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PHYSICAL PRINCIPLES OF SOLAR CELLS [PHYSIKALISCHE GRUNDLAGEN DER SOLARZELLEN]. G. Schneider (Braunschweig, Technische Universität, Braunschweig, West Germany), p. 21-1 to 21-28. 12 refs.

SOLAR CELLS AND THEIR USE IN SPACE FLIGHT [SOLARZELLEN UND IHRE ANWENDUNG]. E. Müller (Bölkow GmbH, Ottobrunn, West Germany), p. 22-1 to 22-60. 7 refs.

SOURCES OF ELECTROCHEMICAL ENERGY FOR SPACE FLIGHT, PARTICULARLY THE SYSTEMS Zn/AgO AND H_2O_2 [ELEKTROCHEMISCHE ENERGIEQUELLEN IN DER RAUMFAHRT BESONDERS DIE SYSTEME Zn/AgO UND H_2/O_2]. A. Winsel (Braunschweig, Technische Universität, Braunschweig; Varta AG, Kelkheim, West Germany), p. 23-1 to 23-41. 18 refs.

CONTROLLED VOLTAGE CONVERTER SYSTEMS FOR ON-BOARD ELECTRIC POWER SUPPLIES IN SPACECRAFT [GEREGELTE SPANNUNGSKONVERTER-SYSTEME FÜR ELEKTRISCHE BORDNETZE VON RAUMFLUGKÖRPERN]. D. Hoge, K. Maass, and H. H. Menke (Telefunken AG, Konstanz, West Germany), p. 24-1 to 24-46. 9 refs.

THERMOELECTRIC GENERATORS AND THEIR USE IN SPACE FLIGHT [THERMOGENERATOREN UND IHRE ANWENDUNG IN DER RAUMFAHRT]. T. Renner (Siemens AG, Erlangen, West Germany), p. 25-1 to 25-34. 19 refs.

THERMIONIC ENERGY SOURCES AND THEIR APPLICATIONS [THERMIONISCHE ENERGIEQUELLEN UND ANWENDUNGEN]. R. Langpape (Brown, Boverie et Cie., AG, Heidelberg, West Germany), p. 26-1 to 26-58. 55 refs.

A69-26364
INFLUENCE OF THERMAL AND ELECTRIC CONTACT RESISTANCES ON THE OUTPUT OF THERMOELECTRIC-CONVERSION GENERATORS [INFLUENCE DES RESISTANCES THERMIQUES ET ELECTRIQUES DE CONTACT SUR LE RENDEMENT DES GENERATEURS A CONVERSION THERMO-ELECTRIQUE].
M. Jannot and G. Mordchelles-Regnier (Société Bertin et Cie., Paris, France).
Entropie, Jan.-Feb. 1969, p. 53-58. In French.
Formulation of relations governing the conditions for the most efficient energy output in thermoelectric power generators as a function of the dimensions and connection of the thermal elements. In particular, these relations provide indications concerning the losses due to thermal and electric contact resistances at the junction of the thermal elements with the hot and cold sources. P. v. T.

A69-27479 #
STUDY OF TWO-PHASE MEDIA FOR USE IN MHD DEVICES [ETUDE DES MILIEUX BIPHASES EN VUE DE LEUR UTILISATION DANS DES DISPOSITIFS MHD].
R. Bidard (Compagnie Electro-Mécanique, Paris, France) and J. Sterlini (Compagnie Electro-Mécanique, Centre de Recherches, Le Bourget, France).
IN: ELECTRICITY FROM MHD; INTERNATIONAL ATOMIC ENERGY AGENCY, SYMPOSIUM ON MAGNETOHYDRODYNAMIC ELECTRICAL POWER GENERATION, WARSAW, POLAND, JULY 24-30, 1968, PROCEEDINGS. VOLUME 3 - CLOSED-CYCLE MHD WITH LIQUID-METAL WORKING FLUIDS (Section 2).

Vienna, International Atomic Energy Agency, 1968, p. 1387-1404. In French.
Study of the operation of a two-phase MHD generator employing emulsions of gas (argon or helium) in a liquid metal (Na or NaK). An earlier work described closed loops containing the liquid metal and located entirely within the magnetic field, loops containing an emulsifier followed by an emulsion region (where the fluid expands), a gas separator, and a region where the separated liquid is compressed before being reemulsified. In this work, it is shown that the efficiency of the loops is essentially determined by two factors, one relating to the drift of bubbles relative to the liquid, and the other to the heat exchange between liquid and gas. A method of analytical calculation is presented, which makes it possible to predict the behavior of the emulsion. P. v. T.

A69-27482 #
ENERGY CONVERSION WITH LIQUID-METAL WORKING FLUIDS IN THE MHD-STAUSTRAHLROHR.
R. Radebold (Allgemeine Elektrizitäts-Gesellschaft, Forschungsinstitut, Berlin, West Germany).
IN: ELECTRICITY FROM MHD; INTERNATIONAL ATOMIC ENERGY AGENCY, SYMPOSIUM ON MAGNETOHYDRODYNAMIC ELECTRICAL POWER GENERATION, WARSAW, POLAND, JULY 24-30, 1968, PROCEEDINGS. VOLUME 3 - CLOSED-CYCLE MHD WITH LIQUID-METAL WORKING FLUIDS (Section 2).

Vienna, International Atomic Energy Agency, 1968, p. 1439-1461. 9 refs.
Research supported by the Bundesministerium für Wissenschaftliche Forschung.
Study of the characteristics of a single-stage "fully Carnotized" MHD process involving nonisentropic expansion by preheating the liquid before its partial evaporation by the heat source. The individual problems posed by this much simplified process are analyzed, beginning with the shock waves in the two-phase flow. These are thought to militate against the multistage process. A relatively simple method is introduced for measuring the local

particle velocities in the two-phase flow, using a two-beam laser interferometer. The convergent-divergent shape of the supersonic two-phase nozzle was improved from the conversion efficiency aspect. Special attention was paid to the critical fluid velocity. The investigations were extended from water as an operating medium to alkali metals. Progress was achieved in a new method of injection condensation which largely diminishes boundary-layer friction in addition to the shock waves. A rapid startup of the condensation and thus of the conversion process was ensured. P.v.T.

A69-27484 #

THERMAL EFFICIENCIES OF LIQUID-METAL MHD GENERATOR CYCLES.

Z. Bayer (Československá Akademie Věd, Ústav Termomechaniky, Prague, Czechoslovakia).

IN: ELECTRICITY FROM MHD; INTERNATIONAL ATOMIC ENERGY AGENCY, SYMPOSIUM ON MAGNETOHYDRODYNAMIC ELECTRICAL POWER GENERATION, WARSAW, POLAND, JULY 24-30, 1968, PROCEEDINGS. VOLUME 3 - CLOSED-CYCLE MHD WITH LIQUID-METAL WORKING FLUIDS (Section 2).

Vienna, International Atomic Energy Agency, 1968, p. 1477-1499. 5 refs.

The paper deals with the question whether and to what extent it is possible to improve the thermal efficiency by suitably arranging the cycle, choosing the optimum cycle parameters and the working fluid. The expression for thermal efficiency of an entirely ideal cycle is given, and the dependence on the main cycle parameters is indicated. The approximate optimum energy distribution to the individual mixing stages is derived, from which results the total improvement caused by n-stage nozzle arrangement. From the non-idealized cycle the significance of individual partial irreversibilities is determined. Some medium is taken as a working fluid, and this is characterized by a set of parameters. Of these parameters, the specific heat of the liquid phase and the critical temperature proved to be especially significant. With an increase of former parameter and a decrease of the second, the thermal efficiency increases. On the other hand, an increase of the temperature of condensation, though unfavorable for an independent MHD cycle, gives an increase of combined cycle thermal efficiency. Calculations indicate that the influence of irreversibilities in the cycle is very pronounced so that the thermal efficiency of an independently working MHD cycle is relatively low, about 5%. In a combined arrangement, which enables economical utilization of the waste heat of the MHD cycle in a low-temperature cycle - e.g., in a steam-turbine cycle - a thermal efficiency of about 43% is attainable. (Author)

A69-27485 #

ANALYTICAL AND EXPERIMENTAL STUDIES OF LIQUID-METAL FARADAY GENERATORS.

M. Petrick and J. Roberts (Argonne National Laboratory, Argonne, Ill.).

IN: ELECTRICITY FROM MHD; INTERNATIONAL ATOMIC ENERGY AGENCY, SYMPOSIUM ON MAGNETOHYDRODYNAMIC ELECTRICAL POWER GENERATION, WARSAW, POLAND, JULY 24-30, 1968, PROCEEDINGS. VOLUME 3 - CLOSED-CYCLE MHD WITH LIQUID-METAL WORKING FLUIDS (Section 2).

Vienna, International Atomic Energy Agency, 1968, p. 1501-1520. 6 refs.

Description of a computational procedure which adequately predicts the performance of liquid-metal two-phase flow generators. The studies indicate that the predicted high performance of the liquid-metal MHD power system (Petrick and Roberts, 1967) should be realizable. The relative velocity does not increase greatly across the generator; in fact, the data in many instances show that the relative velocity decreases. The end losses in the dc generator can be readily controlled either through magnetic field overhang or by the use of insulating vanes. Reductions of 80 to 90% in electric end loss have been demonstrated when compared to an abrupt termination of the magnetic field. An actual overall mechanical efficiency of 76% was achieved for the single-phase flow generator; the maximum efficiency for the two-phase flow generator was in the range of 50 to 58%. The flow through the generator appears to be very stable, as evidenced by the lack of large pressure or voltage fluctuations. P.v.T.

A69-27488 #

SOME RESULTS OF AN INVESTIGATION OF A SINGLE-COMPONENT VERSION OF A LIQUID-METAL MHD ENERGY CONVERTER [NEKOTORYE REZUL'TATY IZUCHENIIA ODNOKOMPONENTNOI SKHEMY ZHIDKOMETALLICHESKOGO MGD-PREOBRAZOVANIIA ENERGII].

V. G. Bogomolov, S. D. Dukhovlinov, E. V. Chernykh, and E. M. Shelkov (Akademiia Nauk SSSR, Institut Atomnoi Energii, Moscow, USSR).

IN: ELECTRICITY FROM MHD; INTERNATIONAL ATOMIC ENERGY AGENCY, SYMPOSIUM ON MAGNETOHYDRODYNAMIC ELECTRICAL POWER GENERATION, WARSAW, POLAND, JULY 24-30, 1968, PROCEEDINGS. VOLUME 3 - CLOSED-CYCLE MHD WITH LIQUID-METAL WORKING FLUIDS (Section 2).

Vienna, International Atomic Energy Agency, 1968, p. 1563-1586. 5 refs. In Russian.

Experimental investigation of a liquid-metal single-component MHD conversion cycle employing a condensing ejector in front of the MHD generator. The MHD cycle is analyzed, and relations for calculating the optimal cycle parameters are derived in dimensionless parameters. It is shown that the simplicity and reliability of a single-component cycle can fully compensate for its smaller efficiency as compared to a two-component cycle. V.P.

A69-27489 #

THERMODYNAMIC ANALYSIS OF NEW LIQUID-METAL MHD-GENERATOR CYCLES [TERMODINAMICHESKII ANALIZ NOVYKH TSIKLOV S ZHIDKOMETALLICHESKIM MGD-GENERATOROM].

V. M. Boldyrev, A. E. Morozov, P. P. Orlov, Iu. M. Sias'kin, E. E. Shpil'rain, and K. A. Iakimovich (Akademiia Nauk SSSR, Nauchno-Issledovatel'skii Institut Vysokikh Temperatur, Moscow, USSR).

IN: ELECTRICITY FROM MHD; INTERNATIONAL ATOMIC ENERGY AGENCY, SYMPOSIUM ON MAGNETOHYDRODYNAMIC ELECTRICAL POWER GENERATION, WARSAW, POLAND, JULY 24-30, 1968, PROCEEDINGS. VOLUME 3 - CLOSED-CYCLE MHD WITH LIQUID-METAL WORKING FLUIDS (Section 2).

Vienna, International Atomic Energy Agency, 1968, p. 1587-1611. 9 refs. In Russian.

Analysis of a multicycle MHD generator employing a single-component working fluid and of a single-cycle generator employing a two-component working fluid. The possible means of improving multicycle operation with heat regeneration are examined. The first method is based on the use of a multicycle separator device employing regenerative heaters, the second is based on the use of a multicycle injector with condensation of the vapor phase at optimal vapor and liquid flow rates, and the third makes use of a multicycle injector-separator operating with humid metal vapors. Calculations show that for potassium as the working fluid, a maximum temperature of 1200 K, and a minimum temperature of 790 K, the efficiency of the MHD generator versions proposed ranges between 12 and 14%. V.P.

A69-27491 #

LIQUID-METAL MHD SYSTEMS WITH LAMINAR FLOW AND ELECTRIC POWER GENERATION BY THE SYNCHRONOUS PRINCIPLE [ZHIDKOMETALLICHESKIE MGD-SISTEMY SO SLOISTYM POTOKOM I OTBOROM ELEKTRICHESKOI MOSHCHNOSTI PO SINKHRONNOMU PRINTSIPU].

E. T. Bazeev, V. E. Pavlenko, G. M. Shchegolev (Akademiia Nauk Ukrainskoi SSSR, Institut Tekhnicheskoi Teplofiziki, Kiev, Ukrainian SSR), L. G. Bezusyi, K. I. Kim, and I. M. Postnikov (Akademiia Nauk Ukrainskoi SSR, Institut Elektrodinamiki, Kiev, Ukrainian SSR).

IN: ELECTRICITY FROM MHD; INTERNATIONAL ATOMIC

ENERGY AGENCY, SYMPOSIUM ON MAGNETOHYDRODYNAMIC ELECTRICAL POWER GENERATION, WARSAW, POLAND, JULY 24-30, 1968, PROCEEDINGS. VOLUME 3 - CLOSED-CYCLE MHD WITH LIQUID-METAL WORKING FLUIDS (Section 2).

Vienna, International Atomic Energy Agency, 1968, p. 1635-1646. 6 refs. In Russian.

Discussion of an MHD generator in which the laminar liquid-metal flow is broken up into sections ("liquid pistons") which are brought into motion by the expansion of the vapor enclosed between the sections. Experiments are described which show how such a piston-like flow can be obtained. Using this principle, it is possible to obtain an acceleration process without shocks and mutual slipping of the phases, to greatly reduce the thermal contact surface between the phases, thereby increasing the thermodynamic efficiency of the cycle, to obtain a constant flow rate in the channel, and to generate electric power by means of a synchronously operating MHD generator. V.P.

A69-27492 #

A LIQUID-METAL MHD POWER GENERATION SCHEME USING INTERMITTENT VAPORIZATION.

J. W. Bjerklie (Mechanical Technology, Inc., Latham, N.Y.) and J. R. Powell, Jr. (Brookhaven National Laboratory, Upton, N.Y.).

IN: ELECTRICITY FROM MHD; INTERNATIONAL ATOMIC ENERGY AGENCY, SYMPOSIUM ON MAGNETOHYDRODYNAMIC ELECTRICAL POWER GENERATION, WARSAW, POLAND, JULY 24-30, 1968, PROCEEDINGS. VOLUME 3 - CLOSED-CYCLE MHD WITH LIQUID-METAL WORKING FLUIDS (Section 2).

Vienna, International Atomic Energy Agency, 1968, p. 1647-1664. 11 refs.

A new liquid metal MHD system has been studied which achieves pulses of power by shooting liquid metal slugs through an MHD generator. The slugs are formed upstream of the generator in the power tube. At the end of the tube is a small hot-walled chamber closed off by the liquid metal slug. A spray of liquid metal is admitted for a short time to the chamber so that a vapor is rapidly formed. The vapor then propels the slug down the MHD channel. The way in which the proposed system works is described, including the method of forming slugs and holding them during vapor generation, the auxiliaries required for circulating the liquid metal, and the history of the slug as it travels. An example of MHD generator is also given. The scheme is evaluated by posing an application and verifying the performance. A 400-kWe space power system was chosen. Losses evaluated include heat loss from the vapor to the slug, friction, residual kinetic energy in the slug, pumping power, and magnetic valve power losses. Vapor generation, slug stability, and power generation by MHD were evaluated. Efficiency of the system using 2700°R peak temperature and 1500°R condensing temperature was evaluated with a 60% efficient MHD generator and found to be 14.6%. The proposed system is built up of many low-power units, proving the ability to scale down to very low power levels. Development is discussed and found to depend mostly on materials suitable for the small vapor generating zone. The rest of the system operates at low temperature. Some technology exists for all components of the system. Little new technology is required to make the system a real possibility. Several improvements for the future are suggested that require more advanced technology, but which should offer the possibility of higher efficiency and lighter weight. (Author)

A69-27494 #

ONE-DIMENSIONAL CALCULATIONS ON A FINITE-LENGTH MHD INDUCTION GENERATOR.

M. Heusinkveld (California, University, Lawrence Radiation Laboratory, Livermore, Calif.).

IN: ELECTRICITY FROM MHD; INTERNATIONAL ATOMIC ENERGY AGENCY, SYMPOSIUM ON MAGNETOHYDRODYNAMIC ELECTRICAL POWER GENERATION, WARSAW, POLAND, JULY 24-30, 1968, PROCEEDINGS. VOLUME 3 - CLOSED-CYCLE MHD WITH LIQUID-METAL WORKING FLUIDS (Section 2).

Vienna, International Atomic Energy Agency, 1968, p. 1681-1716. 12 refs.

AEC-sponsored research.

Solution of the problem of the finite-length induction converter in the slit-channel approximation, in which the transverse magnetic field does not vary across the gap. The fluid channel is assumed to be infinitely wide, or infinite-conductivity side shorting bars are assumed for a channel of finite width. Slug flow and scalar electrical conductivity of the channel fluid and sinusoidal time variation are assumed. Results of numerical calculations of the problem of a uniform traveling-wave generator of finite length are presented. These results include magnetic field distribution, electrical impedance, and conversion efficiency as a function of magnetic Reynolds number, generator slip, converter length in wavelengths, and end current. The basic induction equation is deduced and solved in a manner similar to that of the one-dimensional case, giving a qualitative idea of the error incurred in the use of the one-dimensional approximation. F.R.L.

A69-27495 #

DEVELOPMENT OF A LIQUID FLOW MHD ALTERNATING CURRENT GENERATOR [DETERMINATION D'UN GENERATEUR ALTERNATIF MHD A VEINE LIQUIDE].

M. Kant and R. Bonnefille (Paris, Université, Laboratoires de Genie Electrique, Fontenay-aux-Roses, Hauts-de-Seine, France).

IN: ELECTRICITY FROM MHD; INTERNATIONAL ATOMIC ENERGY AGENCY, SYMPOSIUM ON MAGNETOHYDRODYNAMIC ELECTRICAL POWER GENERATION, WARSAW, POLAND, JULY 24-30, 1968, PROCEEDINGS. VOLUME 3 - CLOSED-CYCLE MHD WITH LIQUID-METAL WORKING FLUIDS (Section 2).

Vienna, International Atomic Energy Agency, 1968, p. 1717-1729. 9 refs. In French.

Consideration of the current induced in the equivalent rotor section and the resulting field in the pole gap of a liquid-flow MHD generator, and determination of the essential design features of an MHD generator of infinite length. By dividing the generator into five geometric zones, the general equations for the induced current and the resulting magnetic field are established, and their variations are studied as a function of the different parameters. By analyzing the distribution of the induced current in the moving liquid and the conducting lateral walls, it is possible to establish the geometric parameters of the duct and, in particular, the dimensions of the linking bars that play the part of rotor winding heads. The theoretical conclusions are compared with the experimental results obtained from a linear model for slip-field measurement with interchangeable magnetic circuit and windings on the one hand, and from a low-powered liquid sodium generator on the other. F.R.L.

A69-27499 #

MERCURY FLOW WITH A HYDRAULIC SHOCK IN A CHANNEL SITUATED IN A TRANSVERSE MAGNETIC FIELD [TECHENIE RTUTI S GIDRAVLICHESKIM PRYZHKOM V LOTKE V POPERECHNOM MAGNITNOM POLE].

L. A. Vulis, K. E. Dzhaugashtin, and V. T. Iaglenko (Leningradskii Gosudarstvennyi Universitet, Leningrad, USSR).

IN: ELECTRICITY FROM MHD; INTERNATIONAL ATOMIC ENERGY AGENCY, SYMPOSIUM ON MAGNETOHYDRODYNAMIC ELECTRICAL POWER GENERATION, WARSAW, POLAND, JULY 24-30, 1968, PROCEEDINGS. VOLUME 3 - CLOSED-CYCLE MHD WITH LIQUID-METAL WORKING FLUIDS (Section 2).

Vienna, International Atomic Energy Agency, 1968, p. 1791-1799. In Russian.

Analysis of a mercury flow in the presence of a hydraulic shock (an analog to the compression shock in magnetogasdynamics) in an MHD channel, at small magnetic Reynolds numbers. The distribution along the channel length of the characteristic values (rate of motion, thickness of the mercury layer, electric current density, etc.) is determined over a range of the principal parameters (Froude number, magnetic interaction, load factor, divergence of the channel, etc.) from calculations performed with a digital computer in a quasi-

one-dimensional approximation. The influence of a hydraulic shock on the nature of the flow in a transverse magnetic field is determined, and relations describing this motion are derived. V.P.

A69-27502 #
HIGH-FREQUENCY VARIABLE FLUID AND VARIABLE FIELD VELOCITY MHD GENERATOR.
L. L. Prem (North American Rockwell Corp., Atomics International Div., Canoga Park, Calif.).
IN: ELECTRICITY FROM MHD; INTERNATIONAL ATOMIC ENERGY AGENCY, SYMPOSIUM ON MAGNETOHYDRODYNAMIC ELECTRICAL POWER GENERATION, WARSAW, POLAND, JULY 24-30, 1968, PROCEEDINGS. VOLUME 3 - CLOSED-CYCLE MHD WITH LIQUID-METAL WORKING FLUIDS (Section 2).

Vienna, International Atomic Energy Agency, 1968, p. 1835-1857. Contract No. AF 33(615)-67-C-1928.

Results of analytical and experimental work on the variable fluid and variable field velocity high-frequency induction generator. The interaction between the fluid-dynamic forces and the magnetic field of the stators is analyzed by an appropriate model for a 10-KW 400-cps test generator. The two-pole pair generator is divided into 12 "phase bands," and the power generation is compared for six arbitrarily selected diverging fluid channel shapes. The available kinetic energy is determined by considering the channel frictional losses. Using the energy available for electric power generation, the outputs of the bands are calculated, and the total power output for each phase of the generator is shown as a function of various channel shapes. The detailed design of the generator is described. F.R.L.

A69-27503 * #
PERFORMANCE CAPABILITIES OF LIQUID-METAL MHD INDUCTION GENERATORS.
D. G. Elliott (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.).
IN: ELECTRICITY FROM MHD; INTERNATIONAL ATOMIC ENERGY AGENCY, SYMPOSIUM ON MAGNETOHYDRODYNAMIC ELECTRICAL POWER GENERATION, WARSAW, POLAND, JULY 24-30, 1968, PROCEEDINGS. VOLUME 3 - CLOSED-CYCLE MHD WITH LIQUID-METAL WORKING FLUIDS (Section 2).

Vienna, International Atomic Energy Agency, 1968, p. 1859-1877. 6 refs.

Summary of a method for designing variable-velocity, finite-length induction generators and for estimating their performance. Numerical results are given, showing the effect on efficiency of generator geometry, operating conditions, fluid properties, and power level. Efficiencies of actual generators ranged from 63% at 300 kW to 80% at 40 MW. Efficiency was relatively insensitive to iron gap and winding resistance, and two-phase flows with void fractions as high as 70% could be employed with no loss in efficiency. B.H.

A69-27504 #
THE OPTIMIZATION OF MHD INDUCTION CONVERTERS.
W. Peschka, C. Carpetis, and A. Gann (Deutsche Versuchsanstalt für Luft- und Raumfahrt, Institut für Energiewandlung und elektrische Antriebe, Stuttgart, West Germany).
IN: ELECTRICITY FROM MHD; INTERNATIONAL ATOMIC ENERGY AGENCY, SYMPOSIUM ON MAGNETOHYDRODYNAMIC ELECTRICAL POWER GENERATION, WARSAW, POLAND, JULY 24-30, 1968, PROCEEDINGS. VOLUME 3 - CLOSED-CYCLE MHD WITH LIQUID-METAL WORKING FLUIDS (Section 2).

Vienna, International Atomic Energy Agency, 1968, p. 1879-1889.

Comparison of a single-wavelength design with compensation and a multiwavelength design without compensation for a liquid-metal MHD induction converter. Two converters using the same working fluid are calculated on the assumptions that the power output is the same, the geometrical configuration and dimensions are the same (with the exception of length), the design is optimal within the limits of possible power density, and the end losses are negligible. It is shown that the overall efficiency and power factor of the single-wavelength machine do not exceed the corresponding values of the uncompensated multiwavelength converter. B.H.

A69-27505 #
CYLINDRICALLY CONSTRUCTED MHD INDUCTION CONVERTERS.
H. Weh and P. Appun (Braunschweig, Technische Hochschule, Braunschweig, West Germany).
IN: ELECTRICITY FROM MHD; INTERNATIONAL ATOMIC ENERGY AGENCY, SYMPOSIUM ON MAGNETOHYDRODYNAMIC ELECTRICAL POWER GENERATION, WARSAW, POLAND, JULY 24-30, 1968, PROCEEDINGS. VOLUME 3 - CLOSED-CYCLE MHD WITH LIQUID-METAL WORKING FLUIDS (Section 2).
Vienna, International Atomic Energy Agency, 1968, p. 1891-1906.

Experimental and theoretical investigation of linear inductive MHD converters. It is shown that the effect of losses due to the finite length of the converter can be considerably reduced by using a cylindrical method of construction. It is further shown that since a closed rotating-field winding cannot produce additional harmonics (apart from the ever-present winding-and-slot harmonics), the asymmetrical phase quantities which occur at multiphase windings of finite length can be avoided. Suitable provision can be made for reducing field distortion produced by the entry and exit flow medium, into or out of the field range. Since the end losses are closely incident to these field distortions, greater efficiency can be obtained by cylindrical construction, especially in cases involving a low number of poles. B.H.

A69-27506 #
ELEMENTS OF THE GENERAL TRANSIENT-RESPONSE THEORY OF LIQUID-METAL CONDUCTION MHD GENERATORS [ELEMENTY OBSHCHEI TEORII PEREKHODNYKH REZHIMOV RABOTY ZHIDKOMETALLICHESKIKH MGD-GENERATOROV KONDUKTSIONNOGO TIPA].
A. N. Patrashev, A. G. Riabinin, and A. I. Khozhainov (Akademiia Nauk SSSR, Nauchno-Issledovatel'skii Institut Vysokikh Temperatur, Moscow, USSR).
IN: ELECTRICITY FROM MHD; INTERNATIONAL ATOMIC ENERGY AGENCY, SYMPOSIUM ON MAGNETOHYDRODYNAMIC ELECTRICAL POWER GENERATION, WARSAW, POLAND, JULY 24-30, 1968, PROCEEDINGS. VOLUME 3 - CLOSED-CYCLE MHD WITH LIQUID-METAL WORKING FLUIDS (Section 2).
Vienna, International Atomic Energy Agency, 1968, p. 1907-1933. 16 refs. In Russian.

Development of a transient response theory for ac and dc compensated MHD generators employing a constant magnetic field. It is shown that the system of coupled MHD and Kirchhoff equations can be reduced to a differential equation for the current in the external circuit, and that the order and class of this equation depends on the driving force and external circuit design. Some characteristic cases are examined for typical values of the driving force and the presence of resistance and inductive reactance in the external circuit. The nature of the transient response is analyzed for various values of the liquid-metal flow rate and of the electric current in the external circuit. V.P.

A69-27508 #
RAYLEIGH-TAYLOR INSTABILITY AND METHODS OF STABILIZING IT IN SYNCHRONOUS LIQUID-METAL MHD GENERATORS [NEUSTOICHIVOST' RELEIA-TEILORA V ZHIDKOMETALLICHESKIKH SINKHRONNYKH MGD-GENERATORAKH I SPOSOBY EE STABILIZATSII].
K. I. Kim (Akademiia Nauk Ukrainskoi SSR, Institut Elektrodinamiki, Kiev, Ukrainian SSR).
IN: ELECTRICITY FROM MHD; INTERNATIONAL ATOMIC ENERGY AGENCY, SYMPOSIUM ON MAGNETOHYDRODYNAMIC ELECTRICAL POWER GENERATION, WARSAW, POLAND, JULY 24-30, 1968, PROCEEDINGS. VOLUME 3 - CLOSED-CYCLE MHD WITH LIQUID-METAL WORKING FLUIDS (Section 2).

Vienna, International Atomic Energy Agency, 1968, p. 1965-1975. 7 refs. In Russian.

Analysis of the factors leading to the onset of Rayleigh-Taylor instabilities in synchronous MHD generators employing liquid metal as the working medium. It is shown that for a generator designed to operate in a gravitational force field these instabilities can be suppressed by placing the generator channels in a vertical position. The influence of the gravitational forces can be compensated for by special stator windings producing an accelerated or decelerated traveling field. Another means of suppressing Rayleigh-Taylor instabilities is to provide a generator rated power close to the threshold power. V.P.

A69-27509 #
EXPERIMENTAL RESULTS WITH A LIQUID-METAL MHD INDUCTION CONVERTER.
M. Ulber and T. Schulz (Allgemeine Elektrizitäts-Gesellschaft, Forschungsinstitut, Berlin, West Germany).
IN: ELECTRICITY FROM MHD; INTERNATIONAL ATOMIC ENERGY AGENCY, SYMPOSIUM ON MAGNETOHYDRODYNAMIC ELECTRICAL POWER GENERATION, WARSAW, POLAND, JULY 24-30, 1968, PROCEEDINGS. VOLUME 3 - CLOSED-CYCLE MHD WITH LIQUID-METAL WORKING FLUIDS (Section 2).
Vienna, International Atomic Energy Agency, 1968, p. 1979-2004.
Investigation of an MHD induction converter working with a liquid metal stream. The test was performed in a sodium-potassium loop. The current-voltage characteristics at no load was as expected, and permitted self-excitation with capacitors. The no-load losses were determined, and divided into the iron, channel wall, side bar, and copper losses. Measurements of the magnetic field distribution over the airgap are given. It is shown that by varying the supply voltage and the flow velocity, characteristics curves can be plotted for relating input and output powers, current, and power factors to the slip. All the necessary performance data is thus obtained. Subsequent experiments were extended to an investigation of the self-excited generator. The recorded electrical characteristics were similar to those of the self-excited asynchronous generator. The typical losses due to end-effects and the velocity profile of the fluid were found to be small, owing to the great length of the converter and the low magnetic flux density in the channel. B.H.

A69-27511 #
INVESTIGATION OF A LIQUID-METAL JET MHD GENERATOR [ISSLEDOVANIE ZHIDKOMETALLICHESKOGO STRUINOGO MGD-GENERATORA].
K. I. Dmitriev, E. A. Zotova, I. A. Ivanov, V. S. Presniakov, and F. R. Ulinich (Akademiia Nauk SSSR, Institut Atomnoi Energii, Moscow, USSR).
IN: ELECTRICITY FROM MHD; INTERNATIONAL ATOMIC ENERGY AGENCY, SYMPOSIUM ON MAGNETOHYDRODYNAMIC ELECTRICAL POWER GENERATION, WARSAW, POLAND, JULY 24-30, 1968, PROCEEDINGS. VOLUME 3 - CLOSED-CYCLE MHD WITH LIQUID-METAL WORKING FLUIDS (Section 2).
Vienna, International Atomic Energy Agency, 1968, p. 2035-2046. In Russian.
Description of the results of experimental work on a jet MHD generator with a sodium liquid-metal loop, tested in off-load operation and with various loads. The experiments were carried out with a constant magnetic field and with a magnetic field rising linearly along the generator. The limits of stable operation are determined for both magnetic field conditions. (Author)

A69-27512 #
EXPERIMENTAL INVESTIGATION OF LIQUID-METAL MHD GENERATORS [EKSPERIMENTAL'NYE ISSLEDOVANIIA ZHIDKOMETALLICHESKIKH MGD-GENERATOROV].
G. A. Baranov, V. F. Vasil'ev, V. A. Glukhikh, V. G. Karasev, I. R. Kirillov, and I. V. Lavrent'ev (Nauchno-Issledovatel'skii Institut Elektrofizicheskoi Apparatury, Leningrad, USSR).
IN: ELECTRICITY FROM MHD; INTERNATIONAL ATOMIC ENERGY AGENCY, SYMPOSIUM ON MAGNETOHYDRODYNAMIC ELECTRICAL POWER GENERATION, WARSAW, POLAND, JULY 24-30, 1968, PROCEEDINGS. VOLUME 3 - CLOSED-CYCLE MHD WITH LIQUID-METAL WORKING FLUIDS (Section 2).
Vienna, International Atomic Energy Agency, 1968, p. 2047-2064. In Russian.
Discussion of the results of tests performed with induction, helical, and straight-through MHD generators under independent and self-excitation conditions. The working fluid was an Na-K (78% K) alloy, the alloy temperature ranged between 100 and 150°C, the maximum flow rate was 50 m^3/hr, the maximum pressure was 10 kg/cm^2, the maximum velocity in the generator channels was 40 m/sec, and the maximum magnetic field strength was 1.43 tesla. A plane multipole self-excited induction generator was found to have a maximum output power of 1160 W, a total efficiency of 16.2%, a cos φ of 0.2, and an efficiency without allowance for the hydraulic channel losses of 25.9%. The maximum parameters of a nonself-excited dc generator were an output power of 2 kW and a total efficiency without allowance for channel losses of 40%, and a current of 6 kA. The maximum parameters in the case of self-excitation were 0.4 kW, 30%, and 2 kA, respectively. V.P.

A69-27513 #
INVESTIGATION OF A LIQUID-METAL INDUCTION MHD GENERATOR [ISSLEDOVANIE ZHIDKOMETALLICHESKOGO MGD-GENERATORA INDUKTSIONNOGO TIPA].
Iu. A. Bakanov, L. M. Dronnik, V. E. Strizhak, I. M. Tolmach, and E. I. Iantovskii (Akademiia Nauk SSSR, Energeticheskii Institut, Moscow, USSR).
IN: ELECTRICITY FROM MHD; INTERNATIONAL ATOMIC ENERGY AGENCY, SYMPOSIUM ON MAGNETOHYDRODYNAMIC ELECTRICAL POWER GENERATION, WARSAW, POLAND, JULY 24-30, 1968, PROCEEDINGS. VOLUME 3 - CLOSED-CYCLE MHD WITH LIQUID-METAL WORKING FLUIDS (Section 2).
Vienna, International Atomic Energy Agency, 1968, p. 2065-2083. 7 refs. In Russian.
Experimental verification of the theory of a three-phase high-temperature liquid-metal rotating-field MHD generator. The tests were performed with a generator having a thin-walled helical channel and using potassium as the working fluid. The generator was run for 132 hr at temperatures between 300 and 475°C and 20 hr at 500 to 550°C. The pressure drop did not exceed 18 atm at an input pressure of 25 atm abs. The generator efficiency was found to equal 18%, with a maximum useful power of 500 W. The losses due to viscous dissipation, and the losses in copper, steel, the channel walls, and liquid metal are analyzed, revealing the factor responsible for the lower experimental output power as compared to the theory. The principal factor is the increase in liquid metal losses associated with the nonuniformity of the velocity profile. V.P.

A69-28314 #
REDUCED INDICES OF HEAT REMOVAL INTENSITY AND INITIAL TEMPERATURES IN THERMOELECTRIC DEVICES [PRIVEDENNYE POKAZATELI INTENSIVNOSTI OTVODA TEPLA I NACHAL'NYKH TEMPERATUR V TERMOELEKTRICHESKIKH USTROISTVAKH].
N. O. Skuratovskii (Gosudarstvennyi Nauchno-Issledovatel'skii Energeticheskii Institut, Moscow, USSR).
Geliotekhnika, no. 6, 1968, p. 66-71. In Russian.
Description of a procedure for determining the heat conversion coefficients and the initial temperature of active elements of electric devices powered by solar energy, such as solar energy converters and thermoelectric pumps. Basic in this procedure is the incorporation of experimental values of the constant physical parameters of a given type of device into the energy balance equation for its solar cells. V.Z.

A69-28887 #
COMPARISON OF THE CHARACTERISTICS OF AN IDEAL MHD INDUCTION CONVERTER DURING ITS PUMPING AND GENERATING MODES OF OPERATION, TAKING INTO ACCOUNT THE CURRENT CONDUCTIVITY OF THE CHANNEL WALLS [SRAVNENIE KHARAKTERISTIK IDEAL'NOGO INDUKTSIONNOGO MGD-PREOBRAZOVATELIA V NASOSNOM I GENERATORNOM REZHIMAKH S UCHETOM TOKOPROVODIASHCHIKH STENOK KANALA].
M. Iu. Abritska and R. R. Krishberg (Akademiia Nauk Latviiskoi SSR, Institut Fiziki, Riga, Latvian SSR).

Akademiia Nauk Latviiskoi SSR, Izvestiia, Seriia Fizicheskikh i Tekhnicheskikh Nauk, no. 1, 1969, p. 64-72. In Russian.

Study of an ideal three-phase reactive MHD converter, with the purpose of comparing its pressure cycle with its generator cycle. Equations are derived for calculating the maximum output and the pressure developed. The analysis presented makes it possible to evaluate the effects of the current-conducting walls of the channel in three-phase MHD generators in case an exact calculation meets with difficulties. P.v.T.

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ELECTRON SCATTERING IN THERMIONIC CONVERTERS BY XENON, KRYPTON AND ARGON. F. Rufeh and D. Lieb (Thermo Electron Corp., Waltham, Mass.), p. 1123-1128. 6 refs.

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THE ELECTRON ENERGY DISTRIBUTION FUNCTION AND THE RATE OF NONEQUILIBRIUM IONIZATION IN THE NEAR-CATHODE LAYER OF THE THERMIONIC CONVERTER. F. G. Baksht, B. Ia. Moizhes, and Y. A. Nemchinskii (Akademiia Nauk SSSR, Institut Poluprovodnikov, Leningrad, USSR), p. 1161-1172. 10 refs.

THE PROBE AND SPECTRAL INVESTIGATIONS OF DENSE PLASMA THERMIONIC CONVERTERS. G. A. Diuzhev, A. M. Martzinovskii, B. Ia. Moizhes, G. E. Pikus, V. B. Kaplan, G. A. Shakhnazarova, and V. G. Iur'ev (Akademiia Nauk SSSR, Institut Poluprovodnikov, Leningrad, USSR), p. 1173-1183. 9 refs. A69-29256 14-03]

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SPECTROSCOPIC INVESTIGATIONS IN A THERMIONIC CONVERTER PLASMA. C. G. Stojanoff (Columbia University, New York, N.Y.), W. Hoffmann, and K. Sewing (Stuttgart, Technische Universität, Stuttgart, West Germany), p. 1205-1212. 5 refs.

SPECTRUM OF THE LOW-VOLTAGE DISCHARGE IN A CAESIUM-FILLED DIODE. D. Glas (Eindhoven, Technische Hogeschool, Eindhoven, Netherlands), p. 1213-1218. 6 refs.

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COMMENTS ON WORK FUNCTION THEORIES. E. P. Gyftopoulos (Thermo Electron Corp., Waltham, Mass.), p. 1225-1248. 35 refs.

QUANTUM THERMODYNAMIC MEANING OF ELECTRONEGATIVITY AND WORK FUNCTION. E. P. Gyftopoulos and G. N. Hatsopoulos (Thermo Electron Corp., Waltham, Mass.), p. 1249-1265. 12 refs.

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WORK FUNCTION MEASUREMENTS OF REFRACTORY METALS IN A HIGH PRESSURE CESIUM PLASMA FOR LOW PROBE TEMPERATURE RANGE. V. Bundschuh (Kernforschungsanlage Jülich GmbH, Jülich, West Germany), p. 1295-1302.

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STUDY OF CESIUM ADSORPTION ON TUNGSTEN SINGLE CRYSTALS [ETUDE DE L'ADSORPTION DU CESIUM SUR DES MONOCRISTAUX DE TUNGSTENE]. T. Alleau and J. L. Desplat (Commissariat à l'Energie Atomique, Gif-sur-Yvette, Essonne, France), p. 1337-1345. 15 refs.

GAS ADSORPTION ON TUNGSTEN SINGLE CRYSTALS [ADSORPTION DE GAZ SUR DES MONOCRISTAUX DE TUNGSTENE]. F. P. Dumont and J. Mauries (Commissariat à l'Energie Atomique, Gif-sur-Yvette, Essonne, France), p. 1347-1355. 15 refs.

THE INFLUENCE OF OXYGEN ON THE WORK FUNCTION OF TUNGSTEN. P. Batzies (Brown, Boveri et Cie. AG, Mannheim, West Germany), p. 1357-1365. 10 refs.

WORK FUNCTIONS OF POLYCRYSTALLINE W AND RE IN AN ATMOSPHERE OF CESIUM AND OXYGEN. R. Langpape and A. Minor (Brown, Boveri et Cie. AG, Heidelberg, West Germany), p. 1367-1380. 9 refs.

A CRITICAL EXPERIMENT ON THE NATURE OF ADSORBED CESIUM FILMS. E. Muz (Stuttgart, Technische Universität, Stuttgart, West Germany), p. 1381-1388. 5 refs.

STUDY OF REFRACTORY SURFACES IN THE PRESENCE OF CESIUM VAPORS BY MEANS OF AN EMISSION MICROSCOPE [ETUDE AU MICROSCOPE A EMISSION DE SURFACES REFRACTAIRES EN PRESENCE DE VAPEUR DE CESIUM]. J. L. Desplat and P. Defranould (Compagnie Française Thomson Houston-Hotchkiss Brandt, Bagneux, Hauts-de-Seine, France), p. 1389-1397. 7 refs.

SURVEY OF EXPERIMENTAL WORK IN THE USSR. Iu. L. Danilov, p. 1399-1406.

PANEL DISCUSSION - PRESENT AND FUTURE OF THERMIONIC ENERGY CONVERSION.

THE UNITED STATES' THERMIONIC PROGRAM. G. F. Tape (U.S. Atomic Energy Commission, Washington, D.C.), p. 1407-1416.

APPLICATION OF THERMIONIC ENERGY CONVERSION IN THE USSR. Iu. L. Danilov, p. 1417-1435.

A69-29190 #

DEVELOPMENT OF A 100 WATT(e) ISOTOPE THERMIONIC ELECTRICAL POWER MODULE.

E. W. Williams (General Electric Co., Missile and Space Div., Valley Forge, Pa.) and R. C. Howard (Thermo Electron Corp., Waltham, Mass.).

IN: INTERNATIONAL CONFERENCE ON THERMIONIC ELECTRICAL POWER GENERATION, 2ND, STRESA, ITALY, MAY 27-31, 1968, PROCEEDINGS.

Conference sponsored by the European Nuclear Energy Agency. Luxembourg, EURATOM Center for Information and Documentation (EUR No. 4210 f, e), 1969, p. 281-292; Discussion, p. 293-296.

Description of the development of a primary isotope thermionic electric power module in connection with the Isotope Thermionic Module Development Program of the U.S. Atomic Energy Commission. The modules considered consist of the following major assemblies: (1) heat source; (2) thermionic diode; (3) thermal insulation; (4) electric leads and lead-throughs; and (5) module housing and helium filters. Each of these assemblies is described. Tables are given for design environments, curium module performance parameters; and polonium module performance parameters.

P. v. T.

A69-29191 #

SNAP-13 GENERATOR DEVELOPMENT PROGRAM.

J. B. Dunlay and R. C. Howard (Thermo Electron Corp., Waltham, Mass.).

IN: INTERNATIONAL CONFERENCE ON THERMIONIC ELECTRICAL POWER GENERATION, 2ND, STRESA, ITALY, MAY 27-31, 1968, PROCEEDINGS.
Conference sponsored by the European Nuclear Energy Agency. Luxembourg, EURATOM Center for Information and Documentation (EUR No. 4210 f, e), 1969, p. 297-304.

Description of the generator design in connection with the SNAP-13 program of the U.S. Atomic Energy Commission to develop the technology required for the construction of isotope-heated thermionic converters. More than twenty generators were fabricated and tested with electrical heaters simulating the isotope heat source. All the generators were performance tested, some were life-tested, and three were environmentally tested. By the conclusion of the program, a generator had successfully survived shock and vibration testing, and the life and performance goals had been substantially exceeded. The major results achieved during the electrically heated tests are summarized. The efficiences, power outputs, and lifetimes are presented. The design iterations leading to the successful environment tests are described. P. v. T.

A69-29278 #
THE UNITED STATES' THERMIONIC PROGRAM.
Gerald F. Tape (U.S. Atomic Energy Commission, Washington, D.C.).
IN: INTERNATIONAL CONFERENCE ON THERMIONIC ELECTRICAL POWER GENERATION, 2ND, STRESA, ITALY, MAY 27-31, 1968, PROCEEDINGS.
Conference sponsored by the European Nuclear Energy Agency. Luxembourg, EURATOM Center for Information and Documentation (EUR No. 4210 f, e), 1969, p. 1407-1416.

Outline of U.S. studies of various systems of energy sources and the coupling of these systems with nuclear energy sources. Three reactor concepts which have received primary consideration are discussed. These are the zirconium hydride reactor, the thermionic reactor, and the advanced liquid-metal-cooled reactor. Primary applications for the thermionic systems are advanced manned stations, communication satellites, and lunar bases. An eventual fast reactor application of several hundred kilowatts is hoped for. The development schedule, the reactor experiment itself, and a flight system development are examined. F. R. L.

A69-29279 #
APPLICATION OF THERMIONIC ENERGY CONVERSION IN THE USSR.
Iu. L. Danilov.
IN: INTERNATIONAL CONFERENCE ON THERMIONIC ELECTRICAL POWER GENERATION, 2ND, STRESA, ITALY, MAY 27-31, 1968, PROCEEDINGS.
Conference sponsored by the European Nuclear Energy Agency. Luxembourg, EURATOM Center for Information and Documentation (EUR No. 4210 f, e), 1969, p. 1417-1420; Discussion, p. 1421-1435.

Survey of research concerning thermionic energy conversion in the USSR, and discussion of possible applications in various fields. The advantages of the thermionic converter systems are outlined. The lack of mechanically moving and rotating elements and the resulting reliability may lead to increased use of thermionic converters in spacecraft. P.v.T.

A69-29911 #
DESIGN OF AN MHD GENERATOR WITH AN ELECTRIC CONDUCTIVITY WAVEFORM AT SMALL MAGNETIC REYNOLDS NUMBERS [RASCHET MGD-GENERATORA S VOLNOI ELEKTROPROVODNOSTI PRI MALOM MAGNITNOM CHISLE REINOL'DSA].
L. A. Zakliaz'minskii and S. S. Katsnel'son.
Magnitnaia Gidrodinamika, vol. 5, Jan.-Mar. 1969, p. 77-85. In Russian.

Analysis of the axisymmetric unsteady interaction of a gas with a constant magnetic field and with the field of an electric circuit at small Re_m numbers. The gas flow at $Re_m \to 0$ is taken in the form of an entropy wave (i.e., when the gas pressure and velocity are constant, whereas the temperature and electrical conductivity are arbitrary functions of the gas particle coordinates). The power emanated at the ohmic resistance of the circuit and the electric efficiency of the interaction are determined as functions of the circuit parameters and the conductivity waveform. V. P.

A69-31914 #
A SUPERCRITICAL THERMODYNAMIC POWER CYCLE WITH MHD GENERATOR.
J. Braun (AB Atomenergi, Nyköping, Sweden) and A. S. Roberts, Jr. (Old Dominion College, Norfolk, Va.).
AIAA Journal, vol. 7, Apr. 1969, p. 771-773. 6 refs.

Theoretical investigation of the thermodynamic parameters of a magnetohydrodynamic cycle employing supercritical mercury. The results indicate that (1) induced magnetic fields are small relative to the applied field, (2) the flow is turbulent and the hydrodynamic boundary layer is thin, (3) viscous effects are small, (4) the magnetic body force is of the same order of magnitude as the inertial force, and (5) the gravitational body force may be important for this generator. It is concluded that studies of the magnetohydrodynamic supercritical cycle must concentrate on a search for more suitable fluids, considering even mixtures. The advantages of the supercritical cycle as mentioned by Feher (1968), with the additional asset of the magnetohydrodynamic concept which eliminates moving parts, are cited as providing strong incentives for further work. P.G.

A69-32417
MEDIUM TEMPERATURE FUEL CELLS [PILES A COMBUSTIBLES A MOYENNE TEMPERATURE].
J. Laroche and G. Billaud (EMC - Office National Industriel de l'Azote, Laboratoire de Physico-Chimie, Toulouse, France).
IN: ELECTROCHEMICAL GENERATORS FOR SPACE APPLICATIONS; CENTRE NATIONAL D'ETUDES SPATIALES, INTERNATIONAL CONFERENCE, PARIS, FRANCE, DECEMBER 4-7, 1967, PROCEEDINGS [LES GENERATEURS ELECTROCHIMIQUES POUR APPLICATIONS SPATIALES; CENTRE NATIONAL D'ETUDES SPATIALES, COLLOQUE INTERNATIONAL, PARIS, FRANCE, DECEMBER 4-7, 1967, PROCEEDINGS].
Paris, Dunod Editeur, 1968, p. 135-142. In French.
Research supported by the Direction des Recherches et Moyens d'Essais and the Délégation Générale à la Recherche Scientifique et Technique.

Consideration of the advantages of fuel cells which operate at about 200°C. There is an improvement in the kinetics of the electrochemical reactions, and the use of precious metals is not required. The extraction of the water formed by the electrochemical combustion is accomplished by simple evaporation. It is also easy to evacuate the heat produced in the interior of the cell. F. R. L.

A69-32424
DIFFUSION OF PROTONS IN SOLIDS - APPLICATIONS TO FUEL CELLS [DIFFUSION DES PROTONS DANS LES SOLIDES - APPLICATIONS AUX PILES A COMBUSTIBLE].
M. Christen (Compagnie Générale d'Electricité de Paris, Centre de Recherches, Département Recherches Physiques de Base, Marcoussis, Essonne, France).
IN: ELECTROCHEMICAL GENERATORS FOR SPACE APPLICATIONS; CENTRE NATIONAL D'ETUDES SPATIALES, INTERNATIONAL CONFERENCE, PARIS, FRANCE, DECEMBER 4-7, 1967, PROCEEDINGS [LES GENERATEURS ELECTROCHIMIQUES POUR APPLICATIONS SPATIALES; CENTRE NATIONAL D'ETUDES SPATIALES, COLLOQUE INTERNATIONAL, PARIS, FRANCE, DECEMBER 4-7, 1967, PROCEEDINGS].
Paris, Dunod Editeur, 1968, p. 217-232. 15 refs. In French.

Study of solid membranes with ion conductivity, which are of great interest in the field of fuel cells, because they make possible an easy separation of reagents (form stability), and do not require regeneration (composition stability). It is shown that the perfection of a proton electrolyte would provide new opportunities in the field of energy conversion at medium temperature. F. R. L.

A69-34700
DEVICE FOR INVESTIGATING THERMIONIC ENERGY CONVERTERS.
V. I. Petrov and A. P. Kobarenkov.

(Teplofizika Vysokikh Temperatur, vol. 6, Sept.-Oct. 1968, p. 947-949.)
High Temperature, vol. 6, Sept.-Oct. 1968, p. 911-913. Translation.

Description of the design of a laboratory device for investigating thermionic converters of thermal energy to electrical power. The current-voltage characteristics of the thermionic energy converter may be measured by static and dynamic methods. Measured dynamic current-voltage characteristics of a thermionic energy converter are presented for a tungsten cathode. Z.W.

A69-39027 #
DIRECT CURRENT MHD GENERATORS WITH VARIABLE CONDUCTIVITY, VELOCITY, AND MAGNETIC FIELD.
John J. Roberts, W. Roy Wessel, and Michael Petrick (Argonne National Laboratory, Argonne, Ill.).
Journal of Spacecraft and Rockets, vol. 6, June 1969, p. 729-734. 16 refs.

Discussion of limitations on analytical solutions of the general problem of Faraday dc generators with variable conductivity, velocity, and magnetic field. A two-dimensional numerical solution of this problem is described, and the results are presented in the form of efficiency curves for different types of field extension, and in the form of computer generated pictures of equipotential lines and current lines. Numerical results are compared with known analytical solutions and with some experiments on two-phase flow generators. For rectangular parallelopiped generators, the axial variation in the individual induced voltage due to increasing void fraction is shown to be significantly detrimental to generator performance; contouring on the channel depth to maintain a constant fluid velocity, however, can alleviate this problem. Z.W.

A69-39165 #
ON THE FUNDAMENTAL PHENOMENON OF MAGNETOHYDRODYNAMIC ENERGY CONVERSION.
E. Csörsz (Mátra Regional Metal Works, Sirok, Hungary).
Acta Technica, vol. 65, no. 1-2, 1969, p. 43-55.

Discussion of the fundamental principles of the dc MHD generator using a gas plasma as a working fluid. The interaction between the components of the working fluid in the process of energy conversion is interpreted, and conditions for the validity of analysis are given. The analysis is based on the relationships of plasma equilibrium. The density of the gasdynamic forces acting on various plasma components is presented in a novel way by the product of partial pressure gradients and momentum transfer probabilities. As a result, some basic relationships for the power design of generators are derived. G.R.

A69-39478 #
SUPERCONDUCTING MAGNETS FOR MHD GENERATORS.
Z. J. J. Stekly (Avco Corp., Avco-Everett Research Laboratory, Everett, Mass.).
IN: ELECTRICITY FROM MHD; INTERNATIONAL ATOMIC ENERGY AGENCY, SYMPOSIUM ON MAGNETOHYDRODYNAMIC ELECTRICAL POWER GENERATION, WARSAW, POLAND, JULY 24-30, 1968, PROCEEDINGS. VOLUME 6–INVITED LECTURE, RAPPORTEURS' STATEMENTS AND DISCUSSIONS, ROUND TABLE DISCUSSIONS, INDEXES.

Vienna, International Atomic Energy Agency, 1968, p. 3467-3489. 17 refs.

Review of the main problems concerning the design, construction, and operation of superconducting magnets for MHD generators. The magnetic field concentration and the structural requirements for a saddle-shaped coil geometry are discussed. The characteristics of currently available superconductors are reviewed and compared with normally conducting room temperature and cryogenic conductors. The methods of stabilizing a superconducting winding against the initiation of an uncontrolled propagation of a normal region, and the associated protection against the excessive voltages and temperatures are reviewed. The heat sources are outlined, and their relative importance is discussed. Several large superconducting magnet systems (not only MHD) are compared to show the state of the art of superconducting magnet technology in the U.S. Z.W.

A69-39480 #
FIELDS AND FLOW IN MHD CHANNELS.
L. L. Lengyel (Institut für Plasmaphysik GmbH, Garching, West Germany).
IN: ELECTRICITY FROM MHD; INTERNATIONAL ATOMIC ENERGY AGENCY, SYMPOSIUM ON MAGNETOHYDRODYNAMIC ELECTRICAL POWER GENERATION, WARSAW, POLAND, JULY 24-30, 1968, PROCEEDINGS. VOLUME 6–INVITED LECTURE, RAPPORTEURS' STATEMENTS AND DISCUSSIONS, ROUND TABLE DISCUSSIONS, INDEXES.

Vienna, International Atomic Energy Agency, 1968, p. 3539-3550; Discussion, p. 3550-3553. 20 refs.

Discussion of the distributions of the electric field and current in MHD energy converters, and analysis of certain MHD flow problems. A review is given of recent research concerning (1) the output characteristics of MHD generators, (2) optimization of MHD ducts, (3) use of equivalent electrical circuits, (4) measurements of current-voltage characteristics in simulated MHD generators, and (5) stability considerations applied to MHD boundary layers. MHD Couette flow and flows at abruptly changing duct cross sections are also considered. Z.W.

A69-40131
THE INFLUENCE OF VARIABLE THERMAL CONDUCTIVITY AND VARIABLE ELECTRICAL RESISTIVITY ON THERMOELECTRIC GENERATOR PERFORMANCE.
Jerry S. Lee (North Carolina State University, Raleigh, N.C.).
Energy Conversion, vol. 9, Aug. 1969, p. 91-97. 12 refs.

Derivation of closed-form analytical solutions for the steady-state temperature distribution, power output, and thermal efficiency of a fully insulated thermoelectric power generator with variable thermal conductivity and electrical resistivity. The Seebeck coefficients are assumed constant. The thermal conductivity and electrical resistivity are assumed to be hyperbolic and logarithmic functions of temperature, respectively. The results show that both power output and efficiency increase as the slope of the resistivity vs temperature curve increases. When the electrical resistivity is constant, variable thermal conductivity does not affect the maximum power output, but it does decrease the thermal efficiency. The constant-property analysis yields a better approximation to the maximum power output and the maximum thermal efficiency as the product of the figure of merit (formed from properties evaluated at the average temperature) and the average temperature increases. The constant-property analysis serves as a better approximation to the thermal efficiency than to the power output. P.G.

A69-41363 #
MAGNETOHYDRODYNAMICS (MAGNETODINAMICA FLUIDELOR).
Lazăr Dragoş.
Bucharest, Editura Academiei Republicii Socialiste România, 1969. 476 p. 390 refs. In Rumanian.

An attempt is made to present as precise a mathematical model as possible of the phenomena occurring in the branch of science called magnetohydrodynamics. It is therefore deemed necessary to begin this study by introducing the electromagnetic field equations for continuous flows such as the fluid flows to be considered. In contrast to other works in this field, where the constitutive equations are not mentioned, Ohm's law for moving media and two other constitutive laws for media at rest are introduced, without stating specifically in which hypothesis this approximation is valid. The

magnetohydrodynamics equations are given in integral form, and the differential equations valid for continuous flows are then derived. From the general equations conclusions relative to fluid flow in a magnetic field, the conservation of magnetic lines, turbulent flow, the existence of Bernoulli equations, etc., are deduced. As an immediate application of the flow equations, a study is made of viscous plane-parallel fluid flow and of flow in pipes. A general boundary value problem is formulated, and classical solutions for flows in pipes with rectangular cross sections are considered. A detailed examination is made of the theory of MHD generators. A mathematical model is presented based on the hypothesis that the electrodes are finite, that the magnetic field is applied only in the region of the electrodes, that the fluid is incompressible, and that the flow is steady and plane. The problem is reduced to the integration of a system of second-order partial differential equations with discontinuous or distributed coefficients. The Hall effect and the influence of the induced magnetic field are also studied. The theory of slender profiles in magnetoaerodynamics is considered. A study is made of perfectly conducting incompressible fluid flows and of flows with electromagnetic dissipative effects, the findings are extended to the case of compressible flows, and some general remarks are made about linearized theory. The problem of viscous fluid flows in the presence of slender cylindrical bodies is considered, with special reference to flows in the presence of flat plates at an angle of attack and at zero angle of attack. An investigation is made of discontinuities in magnetohydrodynamics. The case of weak discontinuities or of discontinuities of derivatives of characteristic dimensions is considered, and the findings are extended to the case of strong discontinuities or of discontinuities of the characteristic dimensions themselves. The study of weak discontinuities is based on the general theory of quasi-linear equations and the Cauchy problem. In this connection, it is shown how perfectly conducting fluids can arise, what their propagation velocities are, wavefronts are constructed, and an analytical Cauchy problem is solved. In the case of shock phenomena, the shock equations are given, as well as the geometrical and thermodynamic properties of the fluid flows, and the problem of stability of shock waves is considered. A.B.K.

A69-42236

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, INTER-SOCIETY ENERGY CONVERSION ENGINEERING CONFERENCE, 4TH, WASHINGTON, D.C., SEPTEMBER 22-26, 1969, PROCEEDINGS.

Conference co-sponsored by the American Institute of Aeronautics and Astronautics, the American Nuclear Society, the American Society of Mechanical Engineers, the American Chemical Society, the Institute of Electrical and Electronics Engineers, and the Society of Automotive Engineers.

New York, American Institute of Chemical Engineers, 1969. 1186 p. Members, $30; nonmembers, $40.

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ZIRCONIUM HYDRIDE REACTOR-ORGANIC RANKINE POWER SYSTEMS. J. H. VanOsdol, F. R. Wilson (North American Rockwell Corp., Canoga Park, Calif.), and R. E. Niggemann (Sundstrand Corp., Rockford, Ill.), p. 456-464.

STUDY OF A 300 kWe RANKINE CYCLE ADVANCED NUCLEAR-ELECTRIC SPACE POWER SYSTEM. J. A. Heller, T. A. Moss, and G. J. Barna (NASA, Lewis Research Center, Cleveland, Ohio), p. 465-483. 19 refs.

DESIGN AND PERFORMANCE OF A MOBILE WASTE HEAT ORGANIC RANKINE CYCLE SYSTEM PROVIDING ELECTRIC POWER AND ENVIRONMENTAL CONTROL. E. Kaplan and E. Lodwig (Fairchild Hiller Corp., Bay Shore, N.Y.), p. 484-493.

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ELECTRICAL/THERMAL INTEGRATION OF DYNAMIC POWER AND LIFE SUPPORT SYSTEMS FOR MANNED SPACECRAFT. C. H. Shinbrot and J. V. Coggi (McDonnell Douglas Corp., Santa Monica, Calif.), p. 505-514. 14 refs.

ISOTEC THERMOELECTRIC GENERATOR FOR SPACE POWER. E. J. Steeger and J. E. Cruver (Gulf General Atomic, Inc., San Diego, Calif.), p. 515-521.

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ANALYSIS OF AN OSCILLATING ENGINE FOR POWER GENERATION BASED ON THE "DRINKING BIRD" PRINCIPLE. S. S. Shergill and R. P. Morgan (Missouri, University, Columbia, Mo.), p. 624-638; Appendix, J. P. Fraser (General Electric Co., Schenectady, N.Y.), p. 639-641.

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HOT PERFORMANCE CHARACTERISTICS OF A GAS BEARING BRAYTON CYCLE TURBOALTERNATOR. J. C. Wood, M. E. Valgora, and H. B. Tryon (NASA, Lewis Research Center, Cleveland, Ohio), p. 659-667. 12 refs.

ANALOG COMPUTER STUDIES OF A 2 TO 10 KILOWATTS ELECTRIC BRAYTON CYCLE SPACE POWER SYSTEM INCLUDING STARTUP AND SHUTDOWN. D. A. Cantoni and R. L. Thomas (NASA, Lewis Research Center, Cleveland, Ohio), p. 668-678.

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THE APPLICATION OF BENCH TESTS IN THE DEVELOPMENT OF HEAT-STERILIZABLE BATTERY SEPARATORS. W. von Hartmann (California Institute of Technology, Pasadena, Calif.), p. 715-720. 10 refs.

TWO YEAR FLIGHT PERFORMANCE OF THE LOCKHEED TYPE XI NICKEL-CADMIUM BATTERY. M. J. Teresa and R. E. Corbett (Lockheed Aircraft Corp., Sunnyvale, Calif.), p. 721-729. 5 refs.

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SOLAR ARRAY CONFIGURATIONS AND PERFORMANCE ON THE MARTIAN SURFACE. M. Swerdling and A. Hasbach (California Institute of Technology, Pasadena, Calif.), p. 754-762. 7 refs.

40 WATTS/POUND SPACECRAFT SOLAR ARRAYS. P. A. Dillard (TRW Systems Group, Redondo Beach, Calif.), p. 763-771. 7 refs.

LIGHTWEIGHT LARGE AREA SOLAR ARRAYS. D. D. Abbott (Boeing Co., Seattle, Wash.), p. 772-777. 20 refs.

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GROUND TRANSPORTATION ENERGY TRANSFER. E. J. Ward and K. L. Lawson (U.S. Department of Transportation, Washington, D.C.), p. 778-794.

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ELECTRIC PROPULSION SYSTEM FOR LINEAR INDUCTION MOTOR TEST VEHICLE. G. P. Kalman, D. Irani, and A. U. Simpson (Garrett Corp., Torrance, Calif.), p. 807-817.

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Versuchsanstalt für Luft- und Raumfahrt, Stuttgart, West Germany), p. 818-825.

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A DUTY CYCLE GENERATOR FOR SWITCHING REGULATORS. A. Schloss (California Institute of Technology, Pasadena, Calif.) and P. Gutknecht (Westinghouse Electric Corp., Pittsburgh, Pa.), p. 839-843. 8 refs.

POWER PROCESSING AND CONTROL FOR MILITARY MANPACK FUEL CELL POWER SOURCES. W. B. Kempler and M. E. Cannon (U.S. Army, Electronics Command, Fort Monmouth, N.J.), p. 844-853.

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ENERGY CONVERSION DEVICES IN GROUND TRANSPORTATION. G. G. Leeth (General Electric Co., Santa Barbara, Calif.), p. 933-939.

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LINEAR INDUCTION MOTOR FOR HIGH SPEED GROUND TRANSPORTATION. T. C. Wang (National Taiwan University, Taiwan, China), p. 964-974.

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HIGH FREQUENCY CAPABILITIES OF A NEW POWER THYRISTOR. R. L. Davies (General Electric Co., Auburn, N.Y.), p. 987-991.

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HIGH-EFFICIENCY BOOST REGULATOR DESIGN FOR PLANETARY SPACECRAFT. D. J. Hopper (California Institute of Technology, Pasadena, Calif.), p. 1000-1003.

TRACKING SOLAR ARRAY MAXIMUM POWER BY SENSING ARRAY TEMPERATURE. M. Sussman (NASA, Langley Research Center, Hampton, Va.), p. 1004-1009. 7 refs.

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AVIONIC APPLICATION OF A HEAT PIPE. A. T. Calimbas and R. H. Hulett (Philco-Ford Corp., Palo Alto, Calif.), p. 1016-1024. 8 refs.

EXPERIMENTS WITH A TWO-FLUID HEAT PIPE. K. T. Feldman, Jr. (New Mexico, University, Albuquerque, N. Mex.) and G. L. Whitlow (Energy Conversion Systems, Inc., Albuquerque, N. Mex.), p. 1025-1032. 7 refs.

HEAT PIPES FOR TEMPERATURE CONTROL. W. Bienert (Dyna-Therm Corp., Cockeysville, Md.), p. 1033-1041. 9 refs.

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ECONOMIC HIGH-PRESSURE HYDROGEN-OXYGEN REGENERATIVE FUEL-CELL SYSTEMS. H. J. Allison, R. Ramakumar, and W. L. Hughes (Oklahoma State University, Stillwater, Okla.), p. 1042-1047. 10 refs.

AMMONIA-AIR FUEL CELL SYSTEM. P. L. Terry and O. J. Adlhart (Engelhard Minerals and Chemicals Corp., Newark, N.J.), p. 1048-1051.

THE HYDRAZINE-AIR BI CELL, A SIMPLIFIED FUEL CELL SYSTEM. J. Perry, Jr. and L. J. Rogers (U.S. Army, Electronics Command, Fort Monmouth, N.J.), p. 1052-1056.

A CIRCULATING ELECTROLYTE HYDROGEN/AIR FUEL CELL SYSTEM. C. G. Clow and J. G. Bannochie (Energy Conversion, Ltd., Basingstoke, England), p. 1057-1064.

HIGH POWER DENSITY FUEL CELL. B. Durante (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio), J. K. Stedman, and C. Z. Bushnell (United Aircraft Corp., South Windsor, Conn.), p. 1065-1071.

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STRATEGIES FOR A NATIONAL NUCLEAR ENGINEERING PROGRAM. C. Starr and C. B. Smith (California, University, Los Angeles, Calif.), p. 1072-1080.

A69-42260

DESIGN AND PERFORMANCE ANALYSIS OF SILICON-GERMANIUM RTG's.

Valvo Raag (Resalab Scientific, Menlo Park, Calif.).

IN: AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, INTERSOCIETY ENERGY CONVERSION ENGINEERING CONFERENCE, 4TH, WASHINGTON, D.C., SEPTEMBER 22-26, 1969, PROCEEDINGS.

Conference co-sponsored by the American Institute of Aeronautics and Astronautics, the American Nuclear Society, the American Society of Mechanical Engineers, the American Chemical Society, the Institute of Electrical and Electronics Engineers, and the Society of Automotive Engineers.

New York, American Institute of Chemical Engineers, 1969, p.

395-399. 6 refs.
AEC Contract No. AT (29-2)-2510.

Description of a newly developed analytical technique for the design and performance analysis of radioisotope thermoelectric generators (RTGs). Although of general applicability to RTGs, the newly developed design technique has specifically been developed for generators that use silicon-germanium Air-Vac type thermocouples. The application of the technique to a particular silicon-germanium generator is illustrated in terms of calculated and actual measured performance. (Author)

A69-42261

FURTHER DEVELOPMENT OF THE STAR THERMOELECTRIC PANEL.

Norman C. Miller (North American Rockwell Corp., Atomics International Div., Canoga Park, Calif.).

IN: AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, INTERSOCIETY ENERGY CONVERSION ENGINEERING CONFERENCE, 4TH, WASHINGTON, D.C., SEPTEMBER 22-26, 1969, PROCEEDINGS.

Conference co-sponsored by the American Institute of Aeronautics and Astronautics, the American Nuclear Society, the American Society of Mechanical Engineers, the American Chemical Society, the Institute of Electrical and Electronics Engineers, and the Society of Automotive Engineers.

New York, American Institute of Chemical Engineers, 1969, p. 420-424.

Description of an improved version of the original four-couple section of the Stud and Rocker (STAR) Panel. The new experimental couples incorporate bonded tungsten electrical contacts for the PbTe thermoelectric elements, allowing stable operation at temperatures above 800 deg F. Thermal insulation efficiency has been improved, also. Operational test data show a measured conversion efficiency for the experimental assembly, including all losses, greater than 4.2 per cent. The actual couple efficiency is probably in excess of 4.8 per cent. The life test graph of power output vs time indicates that the stability is consistent with a 3- to 5-year useful life. (Author)

A69-42267

DESIGN AND PERFORMANCE OF A MOBILE WASTE HEAT ORGANIC RANKINE CYCLE SYSTEM PROVIDING ELECTRIC POWER AND ENVIRONMENTAL CONTROL.

Eli Kaplan and Erwin Lodwig (Fairchild Hiller Corp., Stratos Div., Bay Shore, N.Y.).

IN: AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, INTERSOCIETY ENERGY CONVERSION ENGINEERING CONFERENCE, 4TH, WASHINGTON, D.C., SEPTEMBER 22-26, 1969, PROCEEDINGS.

Conference co-sponsored by the American Institute of Aeronautics and Astronautics, the American Nuclear Society, the American Society of Mechanical Engineers, the American Chemical Society, the Institute of Electrical and Electronics Engineers, and the Society of Automotive Engineers.

New York, American Institute of Chemical Engineers, 1969, p. 484-493.

Description of an organic Rankine cycle power system which absorbs heat from the exhaust gas of a 30 kW gas turbine generator, producing an additional 18.9 kW to support electrical loads greater than the gas turbine rated capacity and to power an air conditioning system. Heat rejected from the system provides water and space heating and humidification. Descriptive material and prototype performance test data are included. (Author)

A69-42294

1 KVA THREE-PHASE DC-AC INVERTER WITH DIGITAL CONTROL.

Milton Knight (U.S. Naval Air Systems Command, Washington, D.C.) and Robert Torkildsen (General Electric Co., Lynn, Mass.).

IN: AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, INTERSOCIETY ENERGY CONVERSION ENGINEERING CONFERENCE, 4TH, WASHINGTON, D.C., SEPTEMBER 22-26, 1969, PROCEEDINGS.

Conference co-sponsored by the American Institute of Aeronautics and Astronautics, the American Nuclear Society, the American Society of Mechanical Engineers, the American Chemical Society, the Institute of Electrical and Electronics Engineers, and the Society of Automotive Engineers.

New York, American Institute of Chemical Engineers, 1969, p. 854-860.

Contract No. N 00019-67-C-0546.

Description of a three phase dc-ac inverter showing a low harmonic distortion, good efficiency and packaging capability, and an ability to handle a wide range of load power factors. The frequency is easily stabilized by a simple crystal-controlled clock oscillator holding the output frequency within a few parts per million frequency drift. The basic pulse repetition rate of 9.6 kHz was selected as a compromise between the weight of transformer and filter components and the switching losses which would be encountered in the transistors. Test results on the unit proved the insensitivity of output waveform to load power factor. The efficiency measured at full load is 85 per cent. The package volume of the model described is 0.52 cu ft and its weight is 19.5 lb. P.G.

A70-10754

CASCADED THERMOELEMENTS AND METHODS OF THEIR DESIGN.

M. Gaibnazarov and Iu. N. Malevskii (Gosudarstvennyi Nauchno-Issledovatel'skii Energeticheskii Institut, Moscow, USSR).

IN: SEMICONDUCTOR SOLAR ENERGY CONVERTERS.

Edited by V. A. Baum.

(Translation of Preobrazovateli Solnechnoi Energii na Poluprovodnikakh, Moscow, Izdatel'stvo Nauka, 1968.)

New York, Consultants Bureau, 1969, p. 23-29. 19 refs.

Study of the design and operation of cascaded thermoelements. Some of the most efficient materials, having a sufficiently high figure of merit in a cascaded thermoelement, are identified. Calculated and experimental results are employed to demonstrate that the use of such materials in cascades makes it possible to increase the efficiency of thermoelectric energy converters up to 10 to 14 per cent at working temperatures of 600 to 700 deg C. A description is given of the first practical use of cascaded thermoelements in a solar thermoelectric generator operating with a 380 deg C temperature drop between the hot and cold junctions with an efficiency of 6.5 per cent. Further increase of the hot-junction temperature by employing high-temperature materials in cascades should make it possible to reach even higher efficiencies. (Author)

A70-12068

CO_2 LASER-INDUCED THERMIONIC EMISSION FROM METALS--DIRECT ENERGY CONVERSION.

W. W. Duley (York University, Science and Physics Dept., Centre for Research in Experimental Space, Toronto, Canada).

Canadian Journal of Physics, vol. 47, Nov. 1, 1969, p. 2419-2423. 14 refs.

Discussion of the characteristics of thermionic emission from tungsten and molybdenum targets subjected to focused carbon-dioxide laser radiation, for a variety of excitation conditions. The electron temperature is found to be roughly 8000 deg K for an incident power of 40 W CW. Direct energy conversion processes are discussed. Direct energy conversion is found to occur with surprising efficiency, even when a relatively crude geometrical arrangement of the electrodes is used. This indicates that high efficiencies may be obtained after optimizing the electrode configuration and electrode work function. Short-circuit currents of 2 to 7 microamp and open-circuit voltages between 0.1 and 0.4 V were observed. V.P.

A70-12513

ADVANCED RANKINE CYCLE PROVIDES BASIC TECHNOLOGY FOR OTHER POWERPLANTS AS WELL.

A. J. Wilson (General Electric Co., Cincinnati, Ohio).

American Institute of Chemical Engineers, Intersociety Energy Conversion Engineering Conference, 4th, Washington, D.C., Sept. 23-26, 1969, Paper 11c. 15 p. 19 refs.

Review of the technology of the advanced Rankine cycle power plant as it evolved over eight years, and of how the high-temperature, refractory alloy, and liquid-metal experience gained in the technology development is applicable to that required for the nuclear Brayton cycle and thermionic power systems. A comparison of technology requirements of the advanced Rankine cycle three-loop system, the three-loop Brayton cycle system, and the two-loop reactor thermionic power plant is given. The advanced Rankine cycle technology is then reviewed to point out the present status and show the relevancy to the needs of the Brayton cycle and thermionic power plants. It is shown that for all three systems the most attractive heat source is a compact fast spectrum nuclear reactor using an alkali-metal coolant which presents one of the most prominent features of the advanced Rankine cycle technology. The most significant advantage of such nuclear reactors is the minimum reactor vessel diameter resulting in minimum shielding weight, so that it may be effectively used in space. Heat-rejection systems of all three power plants may also be most effectively designed by the employment of liquid coolants. The employment of heat pipes as radiation fins attached to the liquid-coolant ducts may be an additional attractive possibility in any of the three systems. Finally, heat exchangers with liquid metals on one or both sides, pumps, valves, structural materials fabrication techniques, and liquid metal purification and handling techniques are all common to the three power plants. O.H.

A70-14716 #

PHYSICAL PHENOMENA IN MAGNETOHYDRODYNAMIC GENERATORS.

R. Ţiţeica, M. Stoenescu, and N. Lupaş (Academia Română, Institutul de Fizică, Bucharest, Rumania).

Revue Roumaine de Physique, vol. 14, no. 9, 1969, p. 1023-1027.

Consideration of the operational principles and parameters of magnetohydrodynamic generators and their thermal efficiency. It is shown how optimum solutions for inlet parameters should be sought. The inlet values of the parameters and their variation along the conversion channel are given for a constant-speed laboratory model. F.R.L.

A70-14754 #

CRITIQUE OF MHD POWER GENERATION.

William D. Jackson, James E. Klepeis (Avco Corp., Avco Everett Research Laboratory, Everett, Mass.), and Michael Petrick (Argonne National Laboratory, Argonne, Ill.).

American Society of Mechanical Engineers, Winter Annual Meeting, Los Angeles, Calif., Nov. 16-20, 1969, Paper 69-WA/Pwr-12. 20 p. 55 refs.

Members, $1.00; nonmembers, $2.00.

Discussion of the recent developments in the field of MHD generators, the status of MHD power generation, and its prospects for large-scale utilization. Several variations of the basic MHD scheme are considered, falling into the category of open-cycle and closed-cycle systems. Primary emphasis is placed on the application of MHD systems to commercial power networks as a means for substantially raising the efficiency of conversion of heat into electricity. O.H.

A70-14797 * #

ANALYTICAL AND EXPERIMENTAL STUDIES OF MHD GENERATOR CATHODES EMITTING IN "SPOT" MODE.

Lester D. Nichols and Maris A. Mantenieks (NASA, Lewis Research Center, Cleveland, Ohio).

American Society of Mechanical Engineers, Winter Annual Meeting, Los Angeles, Calif., Nov. 16-20, 1969, Paper 69-WA/HT-51. 12 p. 13 refs.

Members, $1.00; nonmembers, $2.00.

Derivation of the current-sheath voltage characteristics of a plane cathode emitting current from a thermionic arc spot. The derivation is based upon the requirement of energy conservation at the cathode spot and also in an "ionization region" adjacent to the spot. The results for given gas conditions and electrode work function predict a sheath voltage which decreases with increasing current for a fixed undisturbed (i.e., far from the spot) cathode temperature and with increasing undisturbed cathode temperature at a fixed current. Experimental data support the conclusions predicted by the model. (Author)

A70-14896 * #

PERFORMANCE OF LIFE TESTS AND EFFICIENCY MEASUREMENTS FOR THERMOELECTRIC COUPLES AT CONSTANT THERMAL INPUT POWER.

Philip E. Eggers (Battelle Memorial Institute, Columbus, Ohio).

American Society of Mechanical Engineers, Winter Annual Meeting, Los Angeles, Calif., Nov. 16-20, 1969, Paper 69-WA/Ener-14. 6 p.

Members, $1.00; nonmembers, $2.00.

Contract No. NAS 5-11644.

A test apparatus for the performance of thermoelectric-couple life tests and efficiency measurements at constant thermal input power. Particular emphasis was placed on the development of the thermal insulation system in order to limit parasitic heat losses from the heat source to less than ~15 per cent, hence simulating operating conditions typical of radioisotope-fueled thermoelectric generators. The results of efficiency measurements and a description of the test apparatus and calibration procedure are presented. (Author)

A70-14897 #

THERMAL STEADY-STATE CHARACTERIZATION OF ISOTEC RADIOISOTOPE THERMOELECTRIC GENERATOR.

R. J. Brislin and G. J. E. Willcutt, Jr. (Gulf General Atomic, Inc., San Diego, Calif.).

American Society of Mechanical Engineers, Winter Annual Meeting, Los Angeles, Calif., Nov. 16-20, 1969, Paper 69-WA/Ener-12. 7 p.

Members, $1.00; nonmembers, $2.00.

AEC Contract No. AT (29-2)-2564.

Description of the Gulf General Atomic's isotec thermoelectric generator which employs a series of ten power-producing thermoelectric panels arranged in an octagonal prism around a spherical radioisotope-decay heat source. Heat is transferred between the heat source and panels by radiation, through the panels by conduction, and then dissipated into space by radiation. Essential design features, simplified and detailed radiation and conduction heat transfer models for determination of system operating temperatures, and output performance, are considered. (Author)

A70-16470 #

A NEW STABLE HIGH POWER GIANT-PULSE LASER AT 0.53 μ USING $LiIO_3$.

U. Deserno (Siemens AG, Munich, West Germany) and G. Nath (München, Technische Hochschule, Munich, West Germany).

Physics Letters, vol. 30A, Dec. 15, 1969, p. 483, 484. 9 refs.

Description of an intracavity experiment with a giant-pulse YAG laser using the new nonlinear material $LiIO_3$. Using this material, complete conversion to the second harmonic is obtained. With 50 pulses per second, the green output remains stable in the 10 MW/sq cm intensity range. M.V.E.

A70-18107 #

INSTABILITIES IN NON-EQUILIBRIUM M.H.D. PLASMAS–A REVIEW.

Albert Solbes (MIT, Cambridge, Mass.).

American Institute of Aeronautics and Astronautics, Aerospace

Sciences Meeting, 8th, New York, N.Y., Jan. 19-21, 1970, Paper 70-40. 13 p. 63 refs.
Members, $1.00; nonmembers, $1.50.
USAF-supported research.

In the Hall parameter range (typically larger than 3) characteristic of non-equilibrium M.H.D. generators, alkali seeded noble gases are subject to electrothermal (ionization) instabilities. Plane-wave linear stability analyses led to the concept of a critical Hall parameter' above which the plasma is unstable. The dependence of the critical Hall parameter on other plasma parameters has been studied both theoretically and experimentally, leading to a satisfactory agreement between results. Subsequently quasi and non linear analysis have been proposed, aimed at predicting the effect of the fully developed waves on plasma properties. More recently, theoretical and experimental investigations have focused on the wave stabilization problem and on the effect of boundary conditions. We present here a review of the above work and results. (Author)

A70-19321 #
MHD GENERATOR CHARACTERISTICS WITH INSULATOR WALL LOSSES.
Reiner Decher (Washington, University, Seattle, Wash.).
AIAA Journal, vol. 8, Jan. 1970, p. 132-137. 8 refs.

The paper presents an analysis that delineates the important electrical effects of boundary layers on the insulator wall of a magnetohydrodynamic generator. For specified variation of the fluid properties associated with the boundary layer, the electrical characteristics may be used to identify shorting through the insulator wall boundary layer in an experimental investigation. Two numerical examples considering seeded gas MHD generators with equilibrium and nonequilibrium ionization show that if the channel dimension in the magnetic field direction is 10-100 times larger than the boundary-layer thickness, insulator well shorting should have a negligible effect on the generator's performance. The equations are also generalized to investigate the effects of an insulator wall with finite scalar resistivity. (Author)

A70-20703 **Evaluation of molten carbonate fuel cells.** Walter G. Taschek (U.S. Army, Mobility Equipment Command, Fort Belvoir, Va.). In: Annual Power Sources Conference, 23rd, Atlantic City, N.J., May 20-22, 1969, Proceedings.
Conference sponsored by the U.S. Army. Red Bank, N.J., PSC Publications Committee, 1969, p. 22-25. 6 refs.

Examination of the nature of the problems confronting development of molten carbonate fuel cells, with discussion of new approaches to fuel conditioning. The primary problems associated with the fuel cell module are material and fabrication problems. Corrosion of cell components, difficulty in achieving leak-free structures, and failure to control the electrolyte over extended periods are often the cause of premature cell failure and poor performance. For military systems, the preferred approach appears to be a catalytic recycle reformer. Here a portion of the spent fuel is recycled back to the fuel conditioner to supply the needed reactants for the catalytic reforming reaction. It is considered that the molten carbonate fuel cell has the potential of being an attractive cost effective power source for military applications. F.R.L.

A70-21274 **Microwave power rectification with commercial Schottky barrier diodes.** Alan C. Macpherson, Eliot D. Cohen, and Melvin Herndon (U.S. Navy, Naval Research Laboratory, Washington, D.C.). *Journal of Microwave Power*, vol. 4, Dec. 1969, p. 278-285. 7 refs.

The microwave rectification efficiency of several commercially available Schottky barrier diodes was measured between 1 and 7 GHz as a function of power input and dc load resistance. The highest efficiency observed was 89% with 0.6-watt power input at 1 GHz. For a higher-frequency diode, produced by the same manufacturer, efficiencies of 83 and 68% were observed at 4 GHz and 6.4 GHz respectively with an input power of 100 mW. A theory is developed in which diode losses in the back and forward direction are described by four parameters: the back capacitance, the series resistance, the front resistance, and the 'knee' voltage. The diode is imbedded in a lumped circuit, and the efficiency is calculated. The theoretical dependence of the efficiency on the load resistance agrees quite well with the measurements, but the frequency dependence is less satisfactory. (Author)

A70-22249 **Controlled fusion–Plasma heating with lasers.** Robert Holcomb. *Science*, vol. 167, Feb. 20, 1970, p. 1112, 1113.

Discussion of the possibility that advances made in the production of powerful laser pulses during the past few years may help solve some of the problems of generating and heating plasmas. It is noted that the use of lasers in controlled thermonuclear reaction research is already widespread. Lasers are used for standard optical diagnostic techniques such as interferometry and scattering, and are used to study plasma dynamics and shock wave formation. They also have a unique capability in the generation of plasma holograms. These uses are enough to ensure the future of lasers in plasma research. M.M.

A70-24156 # **The optimum load selection of a sectioned MHD generator.** I. I. Shakhnov. In: Polska Akademia Nauk, Instytut Podstawowych Problemów Techniki, Symposium on Advanced Problems and Methods in Fluid Dynamics, 8th, Tarda, Poland, September 18-25, 1967, Proceedings. Edited by W. Fiszdon, P. Kucharczyk, and W. J. Prosnak. Warsaw, Państwowe Wydawnictwo Naukowe (Fluid Dynamics Transactions. Volume 4), 1969, p. 665-669.

Investigation of the optimum load selection of sectioned MHD generators by using a method of stepwise approach. A method of stepwise finding of optimum energy transformation conditions is presented, the results of which indicate a satisfactory agreement of the pressure and density distribution, yielding thus a maximum power value for MHD generators as a whole. O.H.

A70-24469 **The catalytic effectiveness of nickel and nickel boride for anodic hydrazine oxidation on porous carbon electrodes (Die katalytische Wirksamkeit von Nickel und Nickelborid für die anodische Hydrazinoxydation an porösen Kohleelektroden).** W. Wiesener (Zentralinstitut für Kernforschung, Rossendorf; Deutsche Akademie der Wissenschaften, Berlin, East Germany). In: Société d'Etudes de Recherches et d'Applications pour l'Industrie and Société Commerciale d'Applications Scientifiques, International Symposium on Fuel Cells, 3rd, Brussels, Belgium, June 16-20, 1969, Proceedings. Brussels, Presses Académiques Européennes, 1969, p. 215-219. In German.

Investigation of the suitability of carbon electrodes for use as anodes in the oxidation of hydrazine in fuel cells. Findings about the load carrying capacity of porous carbon electrodes impregnated with nickel salt and nickel boride are presented. It is felt that nickel boride and nickel salt possess very favorable catalytic properties for the oxidation of hydrazine and that they form excellent catalysts on porous carbon electrodes in hydrazine fuel cell system. M.V.E.

A70-24570 # **General analysis of an optimal MHD generator with a channel of constant cross-sectional area (K obshchemu analizu optimal'nogo MGD-generatora s postoiannoi ploshchad'iu secheniia kanala).** A. S. Pleshanov and P. P. Lazarev. *Magnitnaia Gidrodinamika*, vol. 5, Oct.-Dec. 1969, p. 9-12. In Russian.

Analysis of an analytical solution to the variational problem of optimizing a linear conduction MHD generator with a constant channel area. The solution studied was previously obtained by Pleshanov (1966) in a quasi-one-dimensional approximation for small Reynolds numbers and an ideal inviscid nonheat-conducting gas of arbitrary electrical conductivity. It is shown that the modes of operation of an MHD channel involving shock waves are not optimal. V.P.

A70-24855 **A cylindrical coaxial MHD generator.** K. R. Rao (Texas, University, Arlington, Tex.) and A. Erteza (New Mexico, University, Albuquerque, N. Mex.). *Applied Scientific Research,* vol. 21, Jan. 1970, p. 427-441. 19 refs.

A MHD generator with a novel geometry is analyzed as a possible dc power source. The generator channel consists of two coaxial cylinders with a smooth annular space between them through which pressure driven ionized gas flows axially. Magnetic poles and electrodes separated by insulators are embedded in both the inner and outer cylinders. A one-dimensional steady state analysis is presented. It is shown that the internal impedance of the generator is a very sensitive function of the ratio of areas of the charge collecting electrodes to that of the magnetic poles. The generator efficiency analysis, on the other hand, indicates that there is an optimum area ratio corresponding to the maximum conversion efficiency. A comparison of the performance characteristics of this generator with those of a generator of rectangular cross section is presented. The average gas temperature and velocity, the magnetic flux density at the poles, and the volume displacement rate, etc., are assumed identical for the two cases in comparison. It is inferred that the novel channel analyzed herein is, in general, superior to the simple rectangular channel in the energy conversion scheme. (Author)

A70-25033 **Commercial thermoelectric generator applications and economic considerations.** M. A. Rubinstein (General Instrument Corp., Newark, N.J.). *(Intersociety Energy Conversion Engineering Conference, Boulder, Colo., Aug. 13-16, 1968.) Energy Conversion,* vol. 9, Dec. 1969, p. 123-129.

Conversion of heat directly to useful electrical energy by means of thermoelectric techniques has moved during the past few years from the laboratory to fully developed production hardware. A brief description is given of presently available commercial TEGs, the thermoelectric materials used and heat sources. The basis of the design of the TEGs is described in light of requirements for commercially acceptable units. A brief analysis is made of the economics of TEGs relative to other competitive power sources, such as batteries and small MG sets to show how TEGs fill a hole in the power spectrum. The inherent reliability and low maintenance needs of TEGs is considered to be of prime importance and demonstrated by presenting a series of applications in actual use and relevant operational and performance characteristics. (Author)

A70-25036 **The contribution of space-charge in slender channel electrogasdynamics.** D. M. France and G. J. Trezek (California, University, Berkeley, Calif.). *Energy Conversion,* vol. 9, Dec. 1969, p. 135-140.

Derivation of a general expression for the axially induced space charge electric field in an electrogasdynamic energy converter for an axially varying charge distribution. By introducing an effective value of the space charge electric field an analytic solution was obtained for the load current in a manner similar to an earlier theory proposed by Gourdine which is devoid of space charge effects. A comparison is made between computed values of the load current, voltage, and power output and experimental data for air over a range of load resistance from 10 to the 7th to 10 to the 11th ohms. The space charge electric field computed for the case of constant axial charge distribution was also considered. (Author)

A70-25371 **Performance of a 35 HP organic Rankine cycle exhaust gas heat powered system.** Erwin Lodwig (Fairchild Hiller Corp., Stratos Div., Bay Shore, N.Y.). *Society of Automotive Engineers, Automotive Engineering Congress, Detroit, Mich., Jan. 12-16, 1970, Paper 700160.* 32 p. Members, $1.00; nonmembers, $1.50. USAF-sponsored research.

An organic Rankine cycle system utilizing waste exhaust gas heat from a 30 KW gas turbine generator set has been built and tested. Utilizing a new fluorocarbon fluid, the system furnishes 18.9 KW of additional electrical power output along with 120,000 BTU/hour for air heating and 190,000 BTU/hour for water heating for environmental control. The primary gas turbine engine fuel control furnishes the speed control for the mechanically locked-in Rankine turbine and permits fuel saving operation under power sharing conditions from full load to idle conditions. This system concept provides electrical energy output at a fuel consumption rate approaching that of the diesel set but at a small fraction of the diesel set weight. (Author)

A70-25525 **MHD power generation: Engineering aspects.** G. J. Womack (Central Electricity Generating Board, Marchwood Engineering Laboratories, Southampton, Hants., England). London, Chapman and Hall, Ltd.; New York, Barnes and Noble, Inc., 1969. 169 p. 91 refs. $9.50.

A basic and comprehensive treatment of the engineering aspects of MHD power generation is presented. The ionization and electrical conductivity of the working gas is examined together with the motion of the conducting incompressible fluid in a magnetic field. Special attention is given to the Saha equation and its different forms. The electrodynamics of an MHD generating duct are considered, starting from simplified electrodynamics of MHD generators and description of the Hall effect of electrons and ions. The basic configurations of an MHD generator are then described and a summary is presented of the applications of the four generator configurations. Special attention is given to the background on which the generating duct geometry is selected. Topics discussed include the derivation of the MHD equations and their approximations, similarity criteria, steady-state compressible flow in Faraday-type MHD generators, and optimization of a generating duct. The various possible MHD power cycles are examined taking into account short-duration MHD generators, central power station MHD-steam generator cycles, liquid metal MHD generators, and conversion efficiency of the MHD generators. A discussion is presented of plant components of the whole MHD-steam plant including high-temperature air heater, combustion chamber, MHD generating duct, magnet, and seed recovery. The ac generation and losses in the MHD generating duct are briefly discussed. Z.W.

A70-25614 * # **Results of initial subsonic tests in the NASA-Lewis closed loop MHD generator.** R. J. Sovie and L. D. Nichols (NASA, Lewis Research Center, Cleveland, Ohio). *Symposium on the Engineering Aspects of Magnetohydrodynamics, 11th, California Institute of Technology, Pasadena, Calif., Mar. 24-26, 1970, Paper.* 12 p. 6 refs.

The NASA-Lewis closed loop MHD generator was designed to study power generation with nonequilibrium ionization using a cesium seeded argon plasma. The results of the first five tests, in which the general design and structural integrity of the loop were studied, have been reported on in a previous paper. This facility has been run subsonically seven times in the past year. These tests evaluated various loop subsystems necessary to supply the proper plasma conditions, such that the basic concepts of low-temperature MHD power generation can be studied. These subsystems include an impurity purge system, a new vapor cesium injection system, a multiple electrode sidewall pre-ionizer system and various starter electrode systems. The necessity of these systems and their performance characteristics are presented. The initial generator data obtained after incorporating these components into the facility are also presented and discussed. (Author)

A70-27330 # **Electrogasdynamic generator with spatial charge neutralization (Elektrogazodinamicheskii generator s neitralizatsiei prostranstvennogo zariada).** A. M. Borok (Vsesoiuznyi Nauchno-Issledovatel'skii Institut Tokov Vysokoi Chastoty, USSR). *Teplofizika Vysokikh Temperatur,* vol. 8, Jan.-Feb. 1970, p. 177-181. 6 refs. In Russian.

Development of a theoretical basis for constructing a high capacity electrogasdynamic generator performing direct thermal-to-electrical energy conversion. The operation of such a generator at

high gas pressures is analyzed. Engineering formulas for generator designs, with specifications for a generator operating at 200 atm and a generator using an aerosol, are given. It is concluded that the specific capacity of these designs may exceed 3000 kW/cu m, providing a high efficiency at relatively low temperatures. V.Z.

A70-27670 **Energy conversion statics.** H. K. Messerle (Sydney, University, Sydney, Australia). New York, Academic Press, Inc., 1969. 357 p. 29 refs. $16.50.

This comprehensive work deals with energy, energy distribution under equilibrium conditions, and processes linking equilibrium states. It provides an original approach to a generalized treatment of energy conversion. A unified language is developed to handle energy conversion problems in fields ranging from thermostatics to electrical systems. The basic ideas are introduced through the use of single and two-port storage elements and systems of multi-port elements. The theory is built around energy with four energy-based postulates and the two laws of energy conservation and dissipation. The theory leans heavily on analytical methods developed for the treatment of lumped parameter circuits and systems. The application of basic theory is discussed, starting with calories and eventually involving the coupling of thermal to mechanical, electrical, and magnetic energies. The concept of quasi-static processes in energy conversion statics is extended to dynamic time dependent processes in general nonconservative systems. G.R.

A70-27758 **Pulsed power fuel cells.** R. A. Sanderson, C. L. Bushnell, and T. F. McKiernan (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). In: Fuel cell systems - II; American Chemical Society, Meeting, 154th, Biennial Fuel Cell Symposium, 5th, Chicago, Ill., September 12-14, 1967, Proceedings. (A70-27757 12-03) Washington, D.C., American Chemical Society (Advances in Chemistry Series, No. 90), 1969, p. 60-69.

Fuel cells operating at high current density under pulsed loading were investigated. Trapped electrolyte cells with catalyzed screen electrodes operating at 160-220 F and free electrolyte cells with dual pore electrodes operating at 400-450 F were tested. Cells were subjected to a single switch closure with low circuit resistance. Current densities up to 15,600 A/sq ft and power densities up to 6240 W/sq ft were recorded. Cell capacitance calculated from response traces was 200-700 farads/sq ft. Tests were also conducted in which the cells were subjected to continuous square wave pulse loading at pulse frequencies of 10-10,000 Hz, pulse durations of 20-95% and pulse amplitudes up to 3600 A/sq ft. Power density at equal cell voltage was found to improve under pulsed loading. (Author)

A70-28654 **Mechanical electromagnet as an MHD dynamo.** I. M. Kirko (Latviiskii Gosudarstvennyi Universitet, Riga, Latvian SSR). (*Akademiia Nauk SSSR, Doklady*, vol. 188, Sept. 11, 1969, p. 330-333.) *Soviet Physics - Doklady*, vol. 14, Mar. 1970, p. 921-923. 10 refs. Translation.

Study of the use of a mechanical electromagnet as a device for achieving direct conversion of mechanical energy into magnetic field energy. The system considered involves an infinite number of conducting layers moving in a magnetic field, with electrical contacts being inserted between the layers so as to produce an electric current generator. The method of confining the magnetic field consists in compensating for the decay of the magnetic field in the conducting medium by a directed motion of the medium, where the magnetic lines of force assume a spiral shape, thus replenishing the magnetic field. (Author)

A70-29492 * # **Technology for nuclear dynamic space power systems.** Robert E. English (NASA, Lewis Research Center, Cleveland, Ohio). *American Nuclear Society, Conference on Aerospace Nuclear Applications, Huntsville, Ala., Apr. 28-30, 1970, Paper.* 19 p. 10 refs.

Discussion of the Brayton, mercury, organic-Rankine, and potassium-Rankine dynamic space power systems for use with nuclear energy sources. The state of development of these systems is described, and their salient characteristics are discussed. For the advanced systems, the supporting technology is briefly reviewed. The power outputs of these systems range from a few kilowatts to perhaps a few megawatts. These systems are comparatively efficient and have reasonable radiator area needs. A considerable amount of technology on these systems has been accumulated for the ultimate realization of these advantages. M.V.E.

A70-30100 * **Fuel cells: Their electrochemistry.** J. O'M. Bockris (Pennsylvania, University, Philadelphia, Pa.) and S. Srinivasan (New York, State University, Buffalo, N.Y.). Research supported by NASA; Grant No. NsG-325. New York, McGraw-Hill Book Co., 1969. 680 p. 514 refs. $20.

The text offered attempts to define and explain the basis of the functioning of fuel cells and the reactions at the electrodes, as well as to provide a basis for the direction of future research. Knowledge of other basic disciplines, in particular hydrodynamics and materials science, is also necessary for the worker concerned with fuel cells. The writing of this book was influenced by the absence of education in electrochemistry in high schools and universities. Direct energy conversion methods and the advantages of the electrochemical method are first discussed, followed by study of basic electrode kinetics. Thermodynamic aspects of electrochemical energy conversion are considered, and some electrode kinetic aspects of electrochemical energy conversion are examined. The kinetics of electrode reactions in porous media are treated, followed by an extensive study of electrocatalysis. Attention is given to electrochemical combustion of organic substances and to electrodic reactions of oxygen. Fuel-cell research techniques are outlined, and types of fuel cells are described. F.R.L.

A70-30531 * **Effect of slots on MHD induction generator efficiency.** D. G. Elliott (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). *(Symposium on Engineering Aspects of Magnetohydrodynamics, 10th, Cambridge, Mass., Mar. 26-28, 1969.) Energy Conversion*, vol. 10, Apr. 1970, p. 73, 74.

Investigation of the effect of finite spacing and finite width of the winding slots on the efficiency of an MHD induction generator. The reduction in efficiency due to these factors is calculated by summing the effects of the resulting harmonics. For a 300 kW lithium generator, the efficiency is reduced by 30, 10, and 3% with 6, 12, and 24 slots (3, 6, and 12 phases), respectively. T.M.

A70-30534 **The effect of air/fuel level in the MHD generator on the operation of an open-cycle MHD-topped power plant.** H. F. Feldmann, D. Bienstock (U.S. Bureau of Mines, Coal Research Center, Pittsburgh, Pa.), and W. H. Simons (West Virginia, University, Morgantown, W. Va.). *Energy Conversion*, vol. 10, Apr. 1970, p. 89-91. 9 refs.

Comparison of the operation of an MHD generator at below stoichiometric air/fuel ratios to the operation at a 5% excess air level. At below stoichiometric ratios, combustion is completed by injecting additional air downstream of the MHD generator. Major advantages of operating at below stoichiometric ratios include increased power densities and reduced air preheating temperatures without loss of the overall thermal efficiency of the plant. T.M.

A70-30535 **Replenishment of electrodes for MHD power generation.** A. C. Warren and P. G. Meier (Central Electricity Generating Board, Research Laboratories, Leatherhead, Surrey, England). *Energy Conversion*, vol. 10, Apr. 1970, p. 93-97. 9 refs.

Investigation of the replenishment of MHD zirconia electrodes directly from a plasma in both open-flame and duct configurations. The zirconia deposited only on the electrodes, and the rate of deposition was a function of injected zirconia particle size and distance along the duct. The results may be adequately explained if it

is assumed that the deposition occurs by molecules subliming from the injected particles and condensing on the electrodes. The data are inconsistent with the view that the particles are deposited directly. T.M.

A70-30536 **EGD energy converter geometry studies.** D. M. France and G. J. Trezek (California, University, Berkeley, Calif.). *Energy Conversion*, vol. 10, Apr. 1970, p. 99-104. 6 refs. Research supported by the Chancellor's Patent Fund.

Investigation of system geometries of the elecrogasdynamic (EGD) energy converter to obtain maximum power efficiencies for the conversion process. A comparison of three slender EGD conversion channels, abrupt expansion, free jet, and divergent, is made with respect to the operating characteristics, current ratio, voltage amplification ratio, and electrical power efficiency. The effect of the channel length parameter of the abrupt expansion and free jet channels on the operating characteristics over a range of load resistance up to 10 to the 11th power ohms is then examined. The results as they relate to the electrical power efficiency indicate a correlation between channel length and load resistance for peak efficiency. O.H.

A70-33474 **The potential of magnetohydrodynamic power sources for airborne applications.** David R. Morgan, Ira H. Bowker, and Jacob A. Adams (USAF, Aeronautical Systems Div., Wright-Patterson AFB, Ohio). In: NAECON '70; Institute of Electrical and Electronics Engineers, National Aerospace Electronics Conference, Dayton, Ohio, May 18-20, 1970, Proceedings.
Dayton, Ohio, Institute of Electrical and Electronics Engineers, Inc., 1970, p. 335-341.

The potential of magnetohydrodynamic power sources for application to future electrical needs on-board military aircraft was recently investigated. Of primary interest was the identification of future airborne applications which could effectively employ this advancing technology. The study effort was organized around the detailed examination of seven specific potential applications, each of which appeared to exploit one or more of the recognized characteristic features of MHD power sources. These seven applications represented a broad spectrum of power levels, operating durations and flight altitudes. Technological projections for both MHD and alternator units were used to assess these competing power sources relative to the requirements of each specific application. The prospects for general airborne applicability was thus established. This detailed analysis was utilized to draw certain useful conclusions and to establish some general observations in regard to the future role of airborne MHD-type electrical generators. (Author)

A70-38481 **Cadmium telluride photocells (Photopiles au tellurure de cadmium).** G. Coste (Centre National d'Etudes Spatiales, Direction des Programmes et du Plan, Paris, France) and J. Lebrun (Compelec, Paris, France). *AFEDES, Cahiers*, no. 2, Jan. 1970, p. 80-85. In French.

Study of cadmium telluride photocells, with outline of their history and general discussion of the photovoltaic effect. Attention is given to current technology in the field, actual performance, and manufacture. It is considered that an overall efficiency of 5 percent could be obtained from mass production photocells, which could be constructed in large sizes at a moderate price. F.R.L.

A70-39225 # **Thermoelectric devices - For space and remote terrestrial sites.** Glen Whiting and John McKiernan (Sandia Corp., Albuquerque, N. Mex.). *Mechanical Engineering*, vol. 92, Aug. 1970, p. 27-31.

Description of the design of thermoelectric generators and problems connected with their development. The significances of the Seebeck coefficient and effects of Peltier and Thomson are explained. The principles of fossil-fueled thermoelectric generators, as well as those using radioisotopes and reactors as the heat source, are briefly described. The problems connected with development of thermoelectric generators are discussed taking into consideration generator section - i.e., fuel source, conversion section, container, heat rejection, and others. The importance of thermal bypass losses for the generator performance is examined. Z.W.

A70-39325 **Survey of liquid metal magnetohydrodynamic energy conversion cycles.** Frederick H. Morse (Maryland, University, College Park, Md.). *Energy Conversion*, vol. 10, July 1970, p. 155-176. 38 refs.

Description and comparison of the proposed liquid-metal MHD cycles with a summary of the present state of their development. A brief report of the evolution and status of liquid-metal MHD power generation systems is presented. The maximum predicted efficiencies for the four basic liquid-metal MHD cycles and all modifications included in this review are tabulated. The maximum cycle temperature ranged from 1120 to 1500 K, with a mean value of 1370 K. The minimum cycle temperature ranged from 700 to 1090 K, with a mean value of 920 K, and the generator was assumed to have an efficiency of 70%. Z.W.

A70-39636 # **Effect of certain factors on the external characteristics and efficiency of MHD generators (Vliianie nekotorykh faktorov na vneshnie kharakteristiki i effektivnost' MGD-generatorov).** A. V. Gubarev and V. A. Gurashvili. *Teplofizika Vysokikh Temperatur*, vol. 8, May-June 1970, p. 634-640. 8 refs. In Russian.

Examination of the effect of unidimensional plasma inhomogeneities on the characteristics of MHD generators. Following problems are analyzed: (1) current-voltage characteristics of MHD generators, (2) effect of the inhomogeneities on the efficiency of an MHD generator, (3) optimum geometrical dimensions of the MHD duct, and (4) efficiency of the energy conversion in MHD systems. Z.W.

A70-39986 * # **A progress report on the JPL liquid-metal MHD cycle.** D. J. Cerini and L. G. Hays (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Massachusetts Institute of Technology, Symposium on Engineering Aspects of Magnetohydrodynamics, 10th, Cambridge, Mass., March 26-28, 1969, Proceedings. Edited by W. D. Jackson and J. E. Klepeis. Everett, Mass., Avco Research Laboratory, 1969, p. 36-38.

Progress in developing a liquid-metal MHD power conversion system is summarized. This system employs cesium and lithium as working fluids at peak temperatures to 1100 deg C. The initial, simplified test system uses NaK and nitrogen at ambient temperature to obtain hydraulic and electrical characteristics for the full size components. Hydraulic and empty-channel electrical tests have been completed for this system. Another test system under construction is a smaller, high temperature (1100 deg C) cesium-lithium loop which is designed to obtain nozzle performance and evaluate the erosion resistance of separator materials. All of the refractory metal components are fabricated and hydraulic evaluation of the nozzle and separator has been concluded. A high power cesium-lithium conversion system, which will operate at 1000 deg C, is being designed. High temperature heat transfer and materials tests to support this effort were completed. Improvements in the cycle efficiency by extracting the power in several stages were calculated and values in the 10% range at 500 kWe appear feasible. (Author)

A70-39988 # **Experimental study of a one-wavelength MHD induction generator.** E. S. Pierson (Illinois, University, Chicago, Ill.) and W. D. Jackson (Avco Everett Research Laboratory, Everett, Mass.). In: Massachusetts Institute of Technology, Symposium on Engineering Aspects of Magnetohydrodynamics, 10th, Cambridge, Mass., March 26-28, 1969, Proceedings. Edited by W. D. Jackson and J. E. Klepeis. Everett, Mass., Avco Research Laboratory, 1969, p. 53-57. 8 refs. Contract No. AF 33(615)-67-C-1375.

Discussion of the design and construction of an experimental MHD induction generator in which electrical and friction losses are readily measured and varied. The design philosophy and constraints are briefly summarized as they define the form of the experimental generator. The basic objective is to perform a careful, controlled experiment where the various loss mechanisms can be studied in detail, so that the design is chosen to allow a maximum amount of flexibility. Particular attention is paid to the region of small slip where small but significant discrepancies have shown up in previous experiments. A number of methods have been proposed to minimize the end losses, but no complete experimental comparison has ever been performed. This generator can be operated without iron overhang, with iron overhang, or with compensating poles; and all three cases can be tested with or without vanes and grading of the exciting winding. The resulting generator design is described for the fluid channel, traveling field structure, and compensating poles. Then the preliminary experimental results with an empty fluid channel are described, with emphasis on the traveling magnetic field. The effect of various arrangements on the smoothness of the traveling field is shown, and it is demonstrated that with proper care an acceptably smooth field is obtained (both in magnitude and phase). M.V.E.

A70-39991 # **Preionization in nonequilibrium plasmas.** Norman A. Evans (GE Space Sciences Laboratory, King of Prussia, Pa.). In: Massachusetts Institute of Technology, Symposium on Engineering Aspects of Magnetohydrodynamics, 10th, Cambridge, Mass., March 26-28, 1969, Proceedings. Edited by W. D. Jackson and J. E. Klepeis. Everett, Mass., Avco Research Laboratory, 1969, p. 100-104. Contract No. AF 44(620)-68-C-0048.

An experimental study of the preionization process in non-equilibrium plasmas has been started in a cesium-seeded argon mixture. The work is being performed in a boron nitride channel containing twelve electrode pairs, each equipped with a discharge holder at a gas stagnation temperature of 1500 deg K, Mach numbers up to M = 0.6 and a transverse magnetic field strength up to B = 22,500 gauss. For discharge currents of three amps the results show that steady, stable behavior is obtained up to M = 0.6 for B = 0, with the discharge holders fully effective in controlling the current path. However, for B greater than 0, discontinuous increases in electrode voltage have been observed, and on the basis of probe readings it was concluded that the first discharge had jumped to the next adjacent holder downstream. Depending on M and B, up to four of these events have been observed and there were strong hysteresis effects on decreasing M or B. Other results show that the presence of a magnetic field causes a significant increase in the power required to establish a given conductivity as well as substantially increasing the recombination rates. In addition, there is apparently a certain preionizing discharge array to achieve a final quasi-constant conductivity at minimum power input. Finally good agreement with theory has been found for the dependence of the final highly non-equilibrium conductivity on the magnetic field and the channel electrode geometry. (Author)

A70-40001 * Jet Propulsion Laboratory, Symposium on Engineering Aspects of Magnetohydrodynamics, 11th, California Institute of Technology, Pasadena, Calif., March 24-26, 1970, Proceedings. Edited by D. G. Elliott. University, Miss., Mississippi, University, 1970. 221 p. $10.00.

Contents:

A70-40003 # **Comparison of experimental and analytical results for a 20-MW combustion-driven Hall configuration MHD generator.** O. K. Sonju, J. Teno (Avco Everett Research Laboratory, Everett, Mass.), and T. R. Brogan. In: Jet Propulsion Laboratory,

Symposium on Engineering Aspects of Magnetohydrodynamics, 11th, California Institute of Technology, Pasadena, Calif., March 24-26, 1970, Proceedings. Edited by D. G. Elliott. University, Miss., Mississippi, University, 1970, p. 5-10. 15 refs.

Results of a continuing effort to upgrade 'design' and 'off-design' analytical techniques for MHD generators. The analytical techniques are applicable to all types of generators, but the work is primarily concerned with the analysis of Hall MHD generators. The techniques used in the analysis, including boundary layer analysis, gas nonuniformity considerations, and electrode drop effects are reviewed. Comparisons between predicted and observed operating characteristics of a previously described 20 MW Hall generator are discussed. Although there are some small discrepancies, the correlation between predicted and observed performance is very good. The analysis is shown to predict the stalling point accurately. F.R.L.

A70-40004 # **The performance of a family of diagonal conducting wall MHD open cycle generators.** J. B. Dicks, Y. C. L. Wu, L. W. Crawford, J. K. Koester, J. W. Muehlhauser, L. Edwards, P. Chang, and J. W. Stephens (Tennessee, University, Tullahoma, Tenn.). In: Jet Propulsion Laboratory, Symposium on Engineering Aspects of Magnetohydrodynamics, 11th, California Institute of Technology, Pasadena, Calif., March 24-26, 1970, Proceedings. Edited by D. G. Elliott. University, Miss., Mississippi, University, 1970, p. 16-28. 6 refs. Contract No. AF 44(620)-69-C-0031.

Experimental and theoretical studies have been made of the performance of a 45 deg diagonal conducting wall generator and a Hall generator of the same physical dimensions. The wall temperature effect is investigated and an arc model is proposed. Aluminum was successfully burned in the combustor. It was found that the coating from burning of aluminum improves the channel performance due to the heating up of the walls. It was found that the fluctuations present in the Hall channel have much higher frequencies than those in the 45 deg DCW channel. The fluctuations grow along the channel in the Hall mode. The presence of the aluminum attenuates the fluctuations. The effect of the law conductivity nonuniformities in the plasma and the coating of the wall has a very profound effect on the performance of the Hall generator. (Author)

A70-40005 # **Electrode size effects in combustion-driven MHD generators.** E. S. Rubin and R. H. Eustis (Stanford University, Stanford, Calif.). In: Jet Propulsion Laboratory, Symposium on Engineering Aspects of Magnetohydrodynamics, 11th, California Institute of Technology, Pasadena, Calif., March 24-26, 1970, Proceedings. Edited by D. G. Elliott. University, Miss., Mississippi, University, 1970, p. 35-40. 7 refs. Contracts No. AF 33(615)-67-C-1127; No. AF 33(615)-69-C-1171.

Comparison of the data from an investigation of effects of electrode size on the performance of a combustion-driven MHD generator with an analytical model of the boundary layer. For the segmented-Faraday mode, an influence of electrode size on generator performance exists which is manifested by lower voltage losses at a larger electrode for similar conditions of surface and gas boundary layer temperature. Decreasing electrode temperature worsens electrode performance, but a larger electrode size continues to have lower losses for a given temperature of the gas boundary layer. For dissimilar boundary layer temperatures, a marked change may occur in the relative performance of different electrode sizes at the same surface temperature. Voltage losses at a sufficiently hot anode reflect an essentially gasdynamic dependence on electrode size and tempera ture, and are reasonably well predicted by a two-dimensiona analytical model incorporating a variable electrical conductivity ir the boundary layers. F.R.L

A70-40011 * # **Results of initial subsonic tests in the NASA-Lewis closed loop MHD generator.** R. J. Sovie and L. D. Nichols (NASA, Lewis Research Center, Cleveland, Ohio). In: Jet Propulsion Laboratory, Symposium on Engineering Aspects of Magnetohydrodynamics, 11th, California Institute of Technology, Pasadena, Calif., March 24-26, 1970, Proceedings. Edited by D. G. Elliott. University, Miss., Mississippi, University, 1970, p. 82-89. 6 refs.

The NASA-Lewis closed loop MHD generator was designed to study power generation with nonequilibrium ionization using a cesium seeded argon plasma. The results of the first five tests, in which the general design and structural integrity of the loop were studied, have been reported on in a previous paper. This facility has been run subsonically seven times in the past year. These tests evaluated various loop subsystems necessary to supply the proper plasma conditions, such that the basic concepts of low temperature (approximately 2100 deg K) MHD power generation can be studied. These subsystems include an impurity purge system, a new vapor cesium injection system, a multiple electrode sidewall pre-ionizer system and various starter electrode systems. The necessity of these systems and their performance characteristics are presented. The initial generator data obtained after incorporating these components into the facility are also presented and discussed. (Author)

A70-40012 # **Performance of a large scale, non-equilibrium MHD generator with rare gases.** II. B. Zauderer and E. Tate (GE Space Sciences Laboratory, Philadelphia, Pa.). In: Jet Propulsion Laboratory, Symposium on Engineering Aspects of Magnetohydrodynamics, 11th, California Institute of Technology, Pasadena, Calif., March 24-26, 1970, Proceedings. Edited by D. G. Elliott. University, Miss., Mississippi, University, 1970, p. 95-100. 7 refs. Navy-supported research.

Results of the conclusion of an experimental study of the operating characteristics of a large, shock tunnel driven, linear MHD generator with noble gas mixtures. The experiments were performed in a Penning mixture consisting of 99% neon and 1% xenon. The electron density, n sub e, was measured at four locations along the generator axis. With n sub e and the electrical measurements, a complete description of the electrical operating characteristics of the generator was obtained. A significant result is that the electrical and plasma properties of this generator were about the same as in a smaller shock tube driven generator having 2% of the volume of the present generator. Thus, the present results can be reasonably expected to apply to considerably larger MHD channels. F.R.L.

A70-40013 # **Current distribution in conducting wall MHD generators.** R. H. Eustis, R. M. Cima, and K. E. Berry (Stanford University, Stanford, Calif.). In: Jet Propulsion Laboratory, Symposium on Engineering Aspects of Magnetohydrodynamics, 11th, California Institute of Technology, Pasadena, Calif., March 24-26, 1970, Proceedings. Edited by D. G. Elliott. University, Miss., Mississippi, University, 1970, p. 119-127. 10 refs. Contract No. AF 33(615)-69-C-1171.

Experiments were conducted in an MHD channel which measured the current distribution to electrodes and conducting sidewalls. It was found that anode current distributions could be predicted by a computer program with satisfactory accuracy but that cathode predictions were unsatisfactory. (Author)

A70-40015 * # **Preliminary experimental results from a one-wavelength MHD induction generator.** E. S. Pierson (Illinois, University, Chicago, Ill.). In: Jet Propulsion Laboratory, Symposium on Engineering Aspects of Magnetohydrodynamics, 11th, California Institute of Technology, Pasadena, Calif., March 24-26, 1970, Proceedings. Edited by D. G. Elliott. University, Miss., Mississippi, University, 1970, p. 161-164. Contracts No. JPL-952453; No. AF 33(615)-67-C-1375.

Preliminary results from an experimental one-wavelength MHD induction generator and test facility are described. The zero-field pressure gradients were up to three times the theoretical values. The measurements indicate that this is probably due to gas entrained in

the liquid. The pressure gradients were reduced by adding more NaK to the storage tank. The results from 37 data points covering fluid velocities from 21.8 to 78.0 ft/sec are summarized. Only operation without compensating poles or insulating vanes is covered, including both normal excitation and excitation with the end coils shorted. Net electrical output power was obtained for these cases, but the efficiency was low. This data also supports the hypothesis of two-phase flow in the generator. (Author)

A70-40257 # **One-dimensional particulate electrogasdynamics.** George J. Trezek and David M. France (California, University, Berkeley, Calif.). *AIAA Journal,* vol. 8, Aug. 1970, p. 1386-1391. 9 refs.

Theoretical analysis of a two-phase particulate electrogasdynamic flow. The effect of the space charge induced electric field force on the solid particle charge carrier is included. The direct mental conditions and their relation to the critical velocity hypothesis. Therefore the evidence for critical velocity is reviewed and discussed with reference to MPD arcs. No basis is found for relating MPD arc exhaust velocity a priori to critical velocity. A one-dimensional flow model of the self-field MPD arc is presented, and a relation is found to exist between exhaust velocity and E/B. In order to relate the exhaust velocity to critical velocity, a detailed analysis of the current sheet structure is necessary. (Author)

A70-42071 Electrogasdynamic generator with neutralization of the space charge. A. M. Borok (Vsesoiuznyi Nauchno-Issledovatel'skii Institut Tokov Vysokoi Chastoty, USSR). (*Teplofizika Vysokikh Temperatur,* vol. 8, Jan.-Feb. 1970, p. 177-181.) *High Temperature,* vol. 8, Jan.-Feb. 1970, p. 166-170. 6 refs. Translation.

Development of a theoretical basis for constructing a high capacity electrogasdynamic generator performing direct thermal-to-electrical energy conversion. The operation of such a generator at high gas pressures is analyzed. Engineering formulas for generator designs, with specifications for a generator operating at 200 atm and a generator using an aerosol, are given. It is concluded that the specific capacity of these designs may exceed 3000 kW/cu m, providing a high efficiency at relatively low temperatures. V.Z.

A70-42499 **Optimization of high-temperature fuel cells of a flat-type design (Optimierung von Hochtemperatur-Brennstoffzellen in Flachzellen-Bauweise).** Hans-Joachim Böhme (Brown, Boveri et Cie. AG, Heidelberg, West Germany). *Raumfahrtforschung,* vol. 14, July-Aug. 1970, p. 154-156. In German.

Optimization study of the design of high-temperature fuel cells with thin disk solid electrolytes. The performance of the cell as a function of disk diameter is investigated taking into account various electrolyte resistivities. An example showing the use of the information presented in the design of a fuel cell with optimum performance is given. G.R.

A70-43361 # **Optimization of the tuning of gas turbine engines (Optimizatsiia otladki gazoturbinnykh dvigatelei).** Iu. V. Kozhevnikov and R. I. Adgamov. *Aviatsionnaia Tekhnika,* vol. 13, no. 2, 1970, p. 73-80. In Russian.

Consideration of the problem of adjusting the rpm, the thrust, the fuel flow rate per second, and the gas temperature in the characteristic cross section of a two-stage gas turbine engine. A general method of achieving this adjustment is proposed, as well as a simplified method which can be used in many particular cases of practical importance. The preparation of the initial data for optimal tuning of gas turbine engines during automated bench tests using computers is described. A.B.K.

A70-43539 # **Low-power-consumption auxiliaries for fuel-cell power systems.** J. K. Johnson (Shell Research, Ltd., Chester, England). *Joint Services Electrical Power Sources Committee, International Power Sources Symposium, 7th, Brighton, England, Sept. 15-17, 1970, Paper 21.* 22 p.

An auxiliary system for a hydrazine-fuelled fuel battery is described in which all the power required by the auxiliaries is drawn for the battery. The external load is constant. Considerations of power economy have led to the use of two gas pumps. One pump generates the pressure difference required across the air electrode while a second pump generates the flow of reactant air against only the flow impedance of the path. The distribution of electrical and mechanical power is given in some detail. The effect, on the design of the auxiliary system, of accommodating changes of external load has also been considered and has led to the introduction of a voltage controller for the auxiliary system. This increases the flow of the auxiliary streams as the demand for load current increases, which is when the fuel battery voltage decreases. (Author)

A70-43541 # **Construction and operation of a hydrazine-oxygen fuel cell module.** H. Kohlmüller, H. Cnobloch, and F. v. Sturm (Siemens AG, Forschungslaboratorium, Erlangen, West Germany). *Joint Services Electrical Power Sources Committee, International Power Sources Symposium, 7th, Brighton, England, Sept. 15-17, 1970, Paper 20.* 17 p. 26 refs. Research supported by the Bundesministerium der Verteidigung.

Description of the construction of a hydrazine fuel cell module using cells with nickel screen anodes and supported oxygen cathodes with silver powder as catalyst. Special importance had to be attached to the design of the electrolyte space, since hydrazine is subject to many harmful secondary reactions. Equations for optimum operation were derived and a Faradaic efficiency of 90% was achieved with a ten-cell battery. The injection of the hydrazine fuel into the circulating electrolyte was controlled by a new hydrazine sensor or by the battery voltage. A catalytic H2O2 decomposer was used for supplying the oxygen. M.M.

A70-44900 # **Optimum number of the load circuits in the Hall-type MHD-generator.** Z. Celiński (Polska Akademia Nauk, Instytut Badań Jądrowych, Warsaw, Poland). *Archiwum Elektrotechniki,* vol. 19, no. 3, 1970, p. 413-422.

Analysis of the optimal load circuit configuration for maximum power extraction from a Hall MHD generator with gas parameters varying strongly along the channel. It is shown that maximum power can be drawn from the generator when its electrodes are connected in a multiterminal mode with n separate load circuits and a specific configuration of terminals. The influence of end effects is taken into account together with the complexity of operation with a large number of load circuits. Results of calculations are given for the case of a relatively large change in gas conductivity between the inlet and outlet of the channel. T.M.

A70-45956 # **Exploring a closed Brayton cycle MHD power system applying NERVA reactor technology.** R. R. Holman and S. Way (Westinghouse Electric Corp., Pittsburgh, Pa.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 7th, Houston, Tex., Oct. 19-22, 1970, Paper 70-1225.* 8 p. 17 refs. Members, $1.50; nonmembers, $2.00.

Study of the NERVA reactor, which makes possible temperatures in closed MHD power cycles up to 2500 K. With such temperatures exceptionally good system efficiencies are realized. Also, thermal equilibrium ionization in a gas such as cesium seeded helium is attractively high. For space applications, a high radiator temperature can be used, leading to low area - e.g., 1 sq ft/kw(e). For terrestrial applications a recuperator would be used. Efficiencies around 50% without bottom plant and 60% with bottom plant would be anticipated. There are two development areas: (1) insurance against cesium damage in the reactor, (2) effective fission product retention. Outlook is promising with extended present technology. (Author)

A70-46399 **Batteries and fuel cells.** M. Barak. *IEE Reviews*, vol. 117, Aug. 1970, p. 1561-1584. 48 refs.

Review of the progress achieved to date in the field of designing portable and transportable power sources. The basic principles of electrochemical power sources are outlined, and the manufacturing processes and performance of the main types are briefly described. Some details are given of new cell types capable of much higher outputs than conventional batteries - in particular, sodium-sulphur, lithium-chlorine, and zinc-air cells. Fuel cells are described in some detail and indications are given of outstanding problems. Finally, the characteristics of the various power sources are summarized, and the relationships between the power and energy densities are illustrated graphically. O.H.

A71-11192 **Fuel cells: Modern processes for the electrochemical productions of energy.** Wolf Vielstich (Bonn, Universität, Bonn, West Germany). Research supported by the Arbeitsgemeinschaft für Industrielle Forschung, the Bundesverkehrsministerium, the Deutsche Forschungsgemeinschaft, the Fraunhofer Gesellschaft zur Förderung der Angewandten Forschung, and the Verband der Chemischen Industrie. (Translation of Brennstoffelemente: Moderne Verfahren zur Elektrochemischen Energiegewinnung, Weinheim, West Germany, Verlag Chemie GmbH, 1965.) London and New York, Wiley-Interscience, 1970. 519 p. 877 refs. $25.

An attempt is made to present a comprehensive but concise account of research and development in the field of the direct generation of electrical energy by electrochemical processes, to the stage achieved in 1964. The results of extensive hitherto unpublished research are included. In introductory chapters, ideas, terminology, and basic physicochemical principles of electrochemical energy conversion are summarized. Special attention is given to the kinetics of electrode processes from a technological point of view. The recent original work of numerous electrode reactions is reported. The physicochemical and technological problems involved in the construction and operation of complete cells are described. The most promising electrochemical methods for electrochemical conversion of heat and nuclear energy into electrical energy are described. The electrochemical methods for storing electric energy are examined together with the separation of the isotopes of hydrogen accompanying the electrolysis of aqueous solutions. In conclusion, the whole field is briefly reviewed and possibilities of future applications of the new sources of energy are discussed. The book is intended not only for electrochemists but for all groups of research workers interested in energy conversion. Z.W.

A71-11193 **Direct energy conversion.** M. A. Kettani (Pittsburgh, University, Pittsburgh, Pa.). Reading, Mass., Addison-Wesley Publishing Co., Inc., 1970. 465 p. 1376 refs. $14.95.

The general aspects of energy conversion are briefly reviewed. Physical principles are then discussed in terms of thermodynamics, quantum mechanics, solid state, and plasma physics. Nine separate methods of converting energy directly are treated in detail. They include fusion power, magnetohydrodynamic, thermoelectric, and thermionic power generation, fuel cells, and electrohydrodynamic, piezoelectric, and ferroelectric power generation. Moreover, more than fifteen additional methods of converting energy directly into electricity are described in less detail. O.H.

A71-12195 # **Influence of leakages on MHD generator characteristics (K voprosu o vliianii utechek na kharakteristiki MGD-generatora).** V. A. Bitiurin (Akademiia Nauk SSSR, Nauchno-Issledovatel'skii Institut Vysokikh Temperatur, Moscow, USSR). *Teplofizika Vysokikh Temperatur*, vol. 8, July-Aug. 1970, p. 885-889. 6 refs. In Russian.

Investigation of the influence of transverse current leakage in an MHD generator channel on the basic energy conversion characteristics in the presence of a Hall effect. Attention is given to the local shunting case where leakage currents to the wall bypass the electrode and the poorly conducting flow region near its surface. It is shown that the electrical parameters of the flow in this case can differ substantially from the corresponding values calculated on the basis of the widely used shunting model involving a concentrated loss resistance connected parallel to the load resistance. T.M.

A71-13704 # **Electrofluid dynamic energy conversion - Present status and research areas.** Maurice Lawson and Hans von Ohain (USAF, Aerospace Research Laboratories, Wright-Patterson AFB, Ohio). American Society of Mechanical Engineers, Paper no. 70-Ener-A, 1970. 20 p. 70 refs. Members, $1.00; nonmembers, $2.00.

This paper presents in depth the major basic performance characteristics of electrofluid dynamic (EFD) energy conversion processes, which are shown to be complementary to magnetofluid dynamic processes. With a view toward making possible effective thermal electric energy conversion without moving parts, the potential compatibility of incorporating low pressure ratio EFD processes into high pressure ratio thermodynamic cycles is shown. Investigations of scaling, similarity, performance characteristics, and the effects of physical properties of working media containing electric charges of one polarity are used as a basis to determine the major problems and corresponding research areas in EFD energy conversion. In general these are: generation of charged colloids; electrode and conversion duct geometry; and fluid dynamic energy transfer phenomena in multicomponent, multiphase flows. Also given are typical configurations of EFD energy converters, and a look at potential applications, especially those associated with encapsulated, long-duration power supply for operations in space, under the ocean, or at remote unattended sites. (Author)

A71-14321 **Optimizing hydrazine-oxygen fuel cells.** H. Kohlmüller (Siemens AG, Forschungslaboratorien, Erlangen, West Germany). *Energy Conversion*, vol. 10, Nov. 1970, p. 201-205. 5 refs. Research supported by the Bundesministerium der Verteidigung.

Consideration of a hydrogen-oxygen fuel cell which has a hydrazine electrode with an active two-phase boundary. This electrode has one or more meshes which are covered with a catalyst which consists of nonnoble metals or their compounds, such as Ni2B, Co2B, or Raney nickel either used alone or as a base for other noble metals (Pd-Ru). The cell also has a supported oxygen electrode. The powder catalyst may consist of Raney silver or carbon with silver. The cover layer of this electrode serves simultaneously as the diaphragm. It must consist of electronically nonconductive material; asbestos is mostly used. F.R.L.

A71-16785 # **Some problems related to the conversion of chemical energy into mechanical work (Nekotorye voprosy preobrazovaniia khimicheskoi energii v mekhanicheskuiu rabotu).** I. M. Kovtun, A. N. Naumov, and S. L. Kosmatov (Vsesoiuznyi Zaochnyi Politekhnicheskii Institut, Moscow, USSR). *Teplofizika Vysokikh Temperatur*, vol. 8, Sept.-Oct. 1970, p. 1056-1063. In Russian.

Theoretical study of the production of work from a chemical reaction resulting from the irreversible mixing of reacting materials without separation of the products of the reaction. Conditions for the production of work during a chemical reaction in a Vant Hoff box are studied when the temperature of expansion is higher than that of contraction. It is shown theoretically that work can be obtained from a chemical reaction conducted without changes in volume in a Vant Hoff box without semipermeable partitions. It is also found that reactions involving no changes in the numbers of moles are necessary for a conversion of chemical-into-mechanical energy in the absence of semipermeable partitions with efficiencies higher than that of a Carnot cycle. V.Z.

A71-20000 **The prospects of fusion power.** William C. Gough and Bernard J. Eastlund (U.S. Atomic Energy Commission, Washington, D.C.). *Scientific American*, vol. 224, Feb. 1971, p. 50-64.

The present state of development of fusion-energy technology is discussed, and remaining problems which have to be solved for the construction and operation of a power-producing controlled-fusion reactor are considered. Various approaches for supplying the needed energy in the future are briefly examined, and an account of research conducted to develop controlled means of releasing fusion energy is given. Fusion reactions regarded as potentially useful in full-scale fusion reactors are considered, and the temperatures and densities obtained in plasma experiments are shown. A survey of the principal schemes devised to confine plasmas is presented. Fusion-reactor designs are discussed, and basic criteria for achieving conditions to operate a fusion reactor are investigated. Environmental advantages of fusion power are examined, and estimates regarding the timetable to fusion power are considered. G.R.

A71-22136 # **Selection of optimum conditions at the inlet of an MHD-generator channel (Vybor optimal'nykh uslovii na vkhode v kanal MGD-generatora).** K. V. Donskoi, Iu. A. Dunaev, E. V. Nazarov, and I. I. Shakhnov. *Magnitnaia Gidrodinamika*, vol. 6, Oct-Dec. 1970, p. 101-105. 8 refs. In Russian.

Analysis of the optimal inlet parameters for an MHD channel employing combustion products of kerosene and gaseous oxygen. The analysis is performed for an ideally sectioned channel and for a channel with solid electrodes of finite length. It is shown that at low chamber pressures, the optimum inlet pressure for the sectioned channel is lower by an order of magnitude than that for the channel with solid electrodes. This difference decreases with increasing chamber pressures. A chamber pressure of roughly 2 atm abs is optimal for maximum power, while a pressure of 18 atm abs is optimum for specific volumetric power. V.P.

A71-23441 # **Optimization theory of Hall MHD generator duct.** Jūrō Umoto and Maomi Makino (Kyoto University, Kyoto, Japan). *Kyoto University, Faculty of Engineering, Memoirs*, vol. 32, Oct. 1970, p. 405-415. 7 refs.

Derivation of a new digital calculation to aid in designing an optimum Hall generator duct with constant velocity and constant or distributed Mach number. The calculation makes an integral given by a Carter minimum that expresses the duct size under the condition of extracting a needed output power when the applied magnetic flux density, mass flow, inlet stagnation pressure, and temperature in the duct are held constant. It is shown that the optimization theory can be applied not only to a diverging rectangular duct, but also to an annular one. F.R.L.

A71-24218 **High pressure ratio centrifugal compressors for small gas turbine engines.** R. E. Morris and D. P. Kenny (United Aircraft of Canada, Ltd., Longueuil, Quebec, Canada). In: Advanced centrifugal compressors. New York, American Society of Mechanical Engineers, 1971, p. 118-146. 10 refs. Research supported by the Defence Research Board of Canada and United Aircraft of Canada.

It is pointed out that poor specific fuel consumption of the gas turbine has been a major factor in preventing its general use. The variation of specific fuel consumption and specific power with cycle pressure ratio and turbine inlet temperature is investigated, and some data on the performance of single stage centrifugal compressors with pressure ratios in the range 10:1 to 15:1 are presented. It is found that a major problem with high pressure ratio compressors is the avoidance of separation within the impeller. Research impellers which have been designed initially by a relatively simple potential flow method are described. Loading diagrams are evaluated by a novel pipe analogy method. A novel diffuser capable of accepting the nonuniform supersonic flow from the impeller with low loss and good operating range is discussed. G.R.

A71-25894 **Power limitation of an incore thermionic cell.** W. Haug and E. Wolf (Stuttgart, Universität, Stuttgart, West Germany). In: Institute of Electrical and Electronics Engineers, Annual Thermionic Conversion Specialist Conference, 9th, Miami Beach, Fla., October 26-29, 1970, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1970, p. 357-360. 6 refs. Research supported by the Bundesministerium für Bildung und Wissenschaften.

The thermal and electrical characteristics of a single incore thermionic cell are determined on the basis of a theoretical model during the steady state operation. For this purpose, a numerical method was developed using the two-dimensional analytical solution of the heat conduction problem for the cylindrical emitter body of the cell. The limitation of electrical power output by a maximum emitter surface temperature (2000 K) and a maximum permissible thermal power (70 W/sq cm) is studied. (Author)

A71-25899 **Optimization of the quasi-vacuum mode thermionic converter.** Morton S. Mayer, John G. DeSteese, and Elric W. Saaski (McDonnell Douglas Astronautics Co., Donald W. Douglas Laboratories, Richland, Wash.). In: Institute of Electrical and Electronics Engineers, Annual Thermionic Conversion Specialist Conference, 9th, Miami Beach, Fla., October 26-29, 1970, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1970, p. 388-394. 16 refs.

Quasi-vacuum mode thermionic energy conversion is the basis of the developing ISOMITE thermionic radionuclide battery concept now being considered for application in space and remote terrestrial power supplies. Two computer codes are described which calculate optimum converter design characteristics for converter modules in the power range from 10 mw(e) to 10 w(e). The codes account for all components of the converter thermal balance except back-emission heating, which appears to be negligible in optimized converters. Use of the computer codes has demonstrated a correlation of converter parameters with emitter thermal flux density. For many space-applicable converters operating in zero gravity, the correlation may be used directly for design purposes. For terrestrial devices where area-independent emitter support losses occur, the basic flux correlation is readily modified. The influence of surface properties on converter efficiency is illustrated by a theoretical comparison of converter output using electrode combinations of tantalum, tungsten, oxygenated tantalum, oxygenated tungsten, and iridium. An experimentally observed surface temperature dependence of the Ta-O-Cs work function minimum region is described and correlated for input to the converter optimization routine. Data from a laboratory test device with oxygenated tantalum electrodes show general agreement with calculation. (Author)

A71-26099 # **Fundamentals of thermionic and magnetohydrodynamic energy conversion (Osnovy termoelektronnogo i magnitogidrodinamicheskogo preobrazovaniia energii).** K. M. Aref'ev and I. I. Paleev. Moscow, Atomizdat, 1970. 216 p. 244 refs. In Russian.

The basic physical processes occurring in thermionic and MHD converters of thermal energy into electric energy are reviewed, including data on the operation of the generators. The basic theory of thermionic emission and gas ionization is explained, the operation of vacuum and quasi-vacuum thermionic converters is described, the elements of low-temperature plasma physics are outlined, and data on the operation of a plasma thermionic converter are presented. The physical bases of MHD conversion are summarized, data on the electrical conductivity of the plasma used in MHD generators are presented, as well as data on the operation of the generators themselves, and the operation of closed-cycle MHD generators under conditions of nonequilibrium ionization is investigated. The operation of liquid-metal and ac MHD generators is also considered. A.B.K.

A71-29879 # **Performance of a large scale, nonequilibrium MHD generator with rare gases.** B. Zauderer and E. Tate (General Electric Co., King of Prussia, Pa.). *AIAA Journal*, vol. 9, June 1971,

p. 1136-1143. 17 refs. Navy-supported research.

An experimental study was performed of the operating characteristics of a shock-tunnel driven, supersonic MHD generator. The following major results were obtained: (1) Uniform preionization was required at the generator entrance to achieve appreciable generator power output. (2) The open circuit, induced voltages were in good agreement with the theory. (3) The electrical characteristics and plasma properties of the loaded, Faraday generator were in agreement with the predictions of the one-dimensional electron conservation equations, and Ohm's law if the conductivity was computed on the assumption that the plasma was homogeneously turbulent. (4) When the slope of the axial velocity and pressure gradients changed signs, a nonstationary shock-wave formed in the generator which led to boundary-layer separation and eventual generator current cutoff. (5) The maximum generator power of 500 kw was equal to 7 1/2% of the thermal power input. (6) The electrical performance of the present generator was similar to that measured in a generator having 2% of the volume of the present generator. It is concluded that electrode conduction losses and shock-wave formations were the two major factors limiting the efficiency of this generator. (Author)

A71-29880 # **Effects of electrode size on the performance of a combustion-driven MHD generator.** E. S. Rubin and R. H. Eustis (Stanford University, Stanford, Calif.). *AIAA Journal*, vol. 9, June 1971, p. 1162-1169. 18 refs. USAF-supported research.

Electrode sizes with length-to-pitch ratios of 0.23, 0.50, and 0.79 were tested in a generator section simulated by three molybdenum electrode pairs located at the downstream end of an MHD channel. Voltage probe data were obtained for electrode surface temperatures between 500 and 1600 K, with gas conductivity in the electrode boundary layer regions established by either a hot or cold upstream wall. At a given load current, larger electrodes were found to have lower voltage losses for similar conditions of surface and gas boundary-layer temperature. For dissimilar boundary layers, reflecting coupling between electrode and boundary-layer temperatures in a cold-electrode generator, total voltage losses for a large electrode pair were equal to or greater than those of a small electrode pair at the same surface temperature. Experimental boundary-layer resistances were in good agreement with analytical predictions for electrode temperatures above 800 K. For cathodes, the boundary-layer resistance was gasdynamic for the case of a hot upstream wall, for electrode current densities below that of saturated thermionic emission at the electrode temperature. O.H.

A71-30801 * **A design for thick film microcircuit dc-to-dc converter electronics.** H. M. Wick, Jr. (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.) and S. Capodici (General Electric Co., Philadelphia, Pa.). *(Institute of Electrical and Electronics Engineers, Power Conditioning Specialists Conference, Greenbelt, Md., Apr. 20, 21, 1970.) IEEE Transactions on Aerospace and Electronic Systems,* vol. AES-7, May 1971, p. 528-531.

The design concept for thick film microcircuit dc-to-dc converter electronics used in the power subsystem of the Thermoelectric Outer Planet Spacecraft is presented. Microcircuits have been used in low power logic circuits for nearly ten years, but only recently have these techniques been applied to power subsystem circuits which operate at higher power levels. Thick film microcircuit techniques have been utilized in a dc-to-dc converter reducing weight by 70%, volume by 80%, and interconnections by 75%. The close piece-part spacing allowed short interconnections and lower dissipation, and reduced noise coupling. The developed microcircuit handled total power levels from one watt to twenty-five watts. (Author)

A71-32212 * # **Performance of the electrically-heated 2 to 15 kWe Brayton power system.** John L. Klann, Richard W. Vernon, David B. Fenn, and Henry B. Block (NASA, Lewis Research Center, Cleveland, Ohio). *American Institute of Aeronautics and Astronautics, American Society of Mechanical Engineers, Institute of Electrical and Electronics Engineers, and Society of Automotive Engineers, Intersociety Energy Conversion Engineering Conference, 5th, Las Vegas, Nev., Sept. 21-25, 1970, Paper.* 7 p. 13 refs.

Initial results from two separate tests of the power conversion system are presented and compared to performance predictions. These results are based on 2250 hours of accumulated testing. About 1000 hours of that time was continuous operation at design temperatures in a vacuum-chamber test. No major technological problems were encountered in system operation. With the design working gas mixture of helium and xenon and at design temperatures, a gross alternator power output up to 12 kilowatts was demonstrated in these initial tests. The corresponding measured power-conversion-system gross efficiency was 33 percent with an estimated net efficiency of 29 percent. Measured conversion efficiencies with the gas mixture of helium and xenon were about 1 percentage point below the predicted level. Measured krypton efficiencies at design temperature exceeded predictions by about 2 percentage points. (Author)

A71-32223 * **The design of components for an advanced Rankine cycle test facility.** J. A. Bond (General Electric Co., Cincinnati, Ohio). *American Institute of Aeronautics and Astronautics, American Society of Mechanical Engineers, Institute of Electrical and Electronics Engineers, and Society of Automotive Engineers, Intersociety Energy Conversion Engineering Conference, 5th, Las Vegas, Nev., Sept. 21-25, 1970, Paper.* 7 p. 6 refs. Contract No. NAS 3-9426. (GESP-451)

The design of a facility for testing components of an advanced Rankine cycle power system is summarized. The facility is a three-loop system in which lithium, potassium and NaK-78 are the working fluids of the primary, secondary and heat-rejection loops, respectively. Design bases and performance predictions for the major loop components, including the lithium heater and the potassium boiler, condenser and preheater, are outlined. (Author)

A71-32274 # **Development and production of electrical machines and magnetic systems using superconductors (O razrabotke i sozdanii elektricheskikh mashin i magnitnykh sistem na sverkhprovodnikakh).** Iu. V. Blokhin, G. G. Borzov, S. N. Pylinina, and V. N. Shakhtarin. In: Certain problems in studying gas discharge plasmas and creating strong magnetic fields (Nekotorye voprosy issledovaniia gazorazriadnoi plazmy i sozdaniia sil'nykh magnitnykh polei). Edited by V. G. Novitskii. Leningrad, Izdatel'stvo Nauka, 1970, p. 132-143. In Russian.

Consideration of the problem of drafting designs of large electrical machines and magnetic systems using superconductors. A description is given of a model of an electrical dc collector machine and of an MHD-type magnetic system using superconductors. It is shown that in the case of a high-power dc collector machine the use of superconducting materials for the excitation winding makes it possible, without adding to the weight of the machine, to increase the power output of the machine by a factor of 2.33 with a simultaneous increase in efficiency of 1.7%. A.B.K.

A71-32853 # **The incore-thermionic-reactor as power supply for a direct-to-home TV satellite.** Wolf Rasch (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für elektrische Antriebe und Energieversorgung, Braunschweig, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, British Interplanetary Society, Société Française d'Astronautique, and Associazione Italiana di Aerotecnica, European Space Symposium, 11th, Berlin, West Germany, May 24-26, 1971, Paper.* 24 p. 15 refs.

Evaluation of the technical problems of a direct-to-home TV satellite, with a view to providing universal TV facilities at low cost. For a power source, the incore thermionic reactor (ITR) was selected. In such a reactor thermal power is converted to electrical power without moving of masses. The temperature level of the waste

heat (600 C) is relatively high, so heat radiation is possible using a relatively small and light radiator. The electric power output can be varied between 20 and 200 kW by variation of the number of thermionic fuel rods, thus providing optimized power-to-weight ratios for all desired powers in this region. The operational lifetime is fixed at two years. The technology involved is considered to be available now. Aspects of launching are discussed. F.R.L.

A71-33037 **Some aspects of the conversion of chemical energy to mechanical work.** I. M. Kovtun, A. N. Naumov, and S. L. Kosmatov (Vsesoiuznyi Zaochnyi Politekhnicheskii Institut, Moscow, USSR). (*Teplofizika Vysokikh Temperatur,* vol. 8, Sept.-Oct. 1970, p. 1056-1063.) *High Temperature,* vol. 8, Sept.-Oct. 1970, p. 983-990. Translation.

Theoretical study of the production of work from a chemical reaction resulting from the irreversible mixing of reacting materials without separation of the products of the reaction. Conditions for the production of work during a chemical reaction in a Vant Hoff box are studied when the temperature of expansion is higher than that of contraction. It is shown theoretically that work can be obtained from a chemical reaction conducted without changes in volume in a Vant Hoff box without semipermeable partitions. It is also found that reactions involving no changes in the numbers of moles are necessary for a conversion of chemical-into-mechanical energy in the absence of semipermeable partitions with efficiencies higher than that of a Carnot cycle. V.Z.

A71-33525 * **Status of advanced Rankine power conversion technology.** Jerry R. Peterson (General Electric Co., Evendale, Ohio), Jack A. Heller, and Martin U. Gutstein (NASA, Lewis Research Center, Cleveland, Ohio). *American Nuclear Society, Annual Meeting, 17th, Boston, Mass., June 13-17, 1971, Paper.* 26 p. 35 refs. (GESP-623)

A summary is presented of the recent development and test results of the advanced Rankine system which is a turboelectric nuclear space power system based upon the boiling-condensing Rankine cycle that employs potassium as the working fluid. The current status of system materials technology, heat transfer components, liquid metal pumps, and the potassium turboalternator is discussed. It is shown that no barrier problems are foreseen, and few areas requiring development remain. The technology has reached the point where a breadboard system test could be conducted with a high probability of initial success. O.H.

A71-34227 * # **Electric power for space satellites.** Charles M. Mackenzie (NASA, Goddard Space Flight Center, Space Power Technology Branch, Greenbelt, Md.). *ITU Telecommunication Journal,* vol. 38, May 1971, p. 245-247.

The electric power system of a space vehicle performs the functions of energy conversion, energy storage, and energy processing. The sources of electric power for today's space programs are chemical, solar, and nuclear. A power system consists of a source, a reserve or storage element, interconnections, and a load. A solar-conversion energy-storage power system is described. The life-limiting factor of the power system is usually the secondary battery used as storage element. G.R.

A71-34720 # **Candidate electrical power systems for Space Station.** L. H. McCarty (General Electric Co., Valley Forge, Pa.) and J. E. Boretz (TRW Systems Group, Redondo Beach, Calif.). *American Institute of Aeronautics and Astronautics, Space Systems Meeting, Denver, Colo., July 19, 20, 1971, Paper 71-825.* 11 p. 7 refs. Members, $1.50; nonmembers, $2.00.

The proposed NASA Space Station demands a highly reliable power system which must deliver 25 kWe throughout the Station's ten-year life. Three candidate power systems proposed for this purpose are described. They are the Zirconium Hydride Reference Reactor teamed with a Brayton cycle or thermoelectric power conversion system, the Isotope-Brayton power system, and the Solar Array-Battery system. The Reactor system offers the greatest growth capacity, the Isotope-Brayton system is the most compact and can be conveniently arranged in modules, and the Solar-Array-Battery system is the most space qualified. O.H.

A71-35273 **Pulsed model of a magnetohydrodynamic generator having a strongly nonequilibrium plasma.** V. S. Golubev, M. M. Malikov, and A. V. Nedospasov (Akademiia Nauk SSSR, Institut Atomnoi Energii, Moscow, USSR). (*Teplofizika Vysokikh Temperatur,* vol. 8, Nov.-Dec. 1970, p. 1265-1273.) *High Temperature,* vol. 8, Nov.-Dec. 1970, p. 1185-1192. 24 refs. Translation.

Study of a pulsed MHD generator model with a strong difference between electron temperature and gas temperature caused by supersonic motion of the preliminarily ionized gas in a strong magnetic field. The current-voltage characteristics of this generator are obtained, and it is found that they correspond to a takeoff power ranging from 20 to 100 W/cu cm. This power and the magnitude of effective conductivity agree quantitatively with the phenomenological theory of a plasma with turbulent conductivity and an effective Hall parameter equal to about unity. Z.W.

A71-36404 * # **Hydrogen depolarized cell for a CO2 concentrator.** Harlan F. Brose (United Aircraft Corp., Hamilton Standard Div., Windsor Locks, Conn.). *American Society of Mechanical Engineers, Society of Automotive Engineers, and American Institute of Aeronautics and Astronautics, Life Support and Environmental Control Conference, San Francisco, Calif., July 12-14, 1971, ASME Paper 71-Av-37.* 8 p. Members, $1.00; nonmembers, $3.00. Contract No. NAS 9-10273.

Carbon dioxide (CO_2) concentrator research has been oriented toward concepts minimizing moving parts and applicable to modular construction. The hydrogen depolarized cell is such a device. The unit utilizes the energy of a fuel cell reaction to pump CO_2 from a low partial pressure at the cathode (air side) to a high partial pressure at the anode (hydrogen side). The process is continuous and is capable of operating efficiently at a cabin CO_2 partial pressure of 1 mm Hg. Hamilton Standard has been conducting prototype cell testing, for the NASA Manned Spacecraft Center in support of the space station prototype (SSP). This paper describes the hydrogen depolarized cell CO_2 concentrator and summarizes the test results obtained from the SSP effort. (Author)

A71-37122 * # **Electrical power systems for space - Achievements and issues.** P. Rex Miller (NASA, Washington, D.C.). *Astronautics and Aeronautics,* vol. 9, Aug. 1971, p. 22-30.

The achievements made in the field of electrical power systems during the past decade of space exploration are reviewed giving attention to batteries, solar cells, fuel cells, and radioisotope thermoelectric generators. It is pointed out that these power systems, upgraded as necessary, can meet NASA mission needs through at least the mid-1970s. Beyond this, however, major improvements in these systems will be required and new systems will have to be introduced to support an orderly advance in space exploration. The existing technology base is examined, and possible progress in technology is discussed. G.R.

A71-37600 **Trends in aircraft propulsion.** George Rosen (United Aircraft Corp., Hamilton Standard Div., Windsor Locks, Conn.). *Canadian Aeronautics and Space Institute, Royal Aeronautical Society, and American Institute of Aeronautics and Astronautics, Anglo-American Aeronautical Conference, 12th, Calgary, Alberta, Canada, July 7-9, 1971, CASI Paper 72/10.* 16 p. 8 refs. Members, $1.25; nonmembers, $2.00.

Propulsion requirements for the next generation of civil aircraft are examined and some new and quite demanding needs are defined -

larger engine sizes, higher take-off thrusts, and much lower noise levels. The remarkable propulsion advances over the past two decades are charted and, from these, projections are made for the next round of improvements. All of the propulsion systems considered incorporate advanced technology gas turbine engines coupled with propulsors having a broad range of bypass ratio - from fans to propellers. This encompasses a new class of high-thrust, low-noise propulsor - the Prop-Fan - which is introduced as a needed intermediate propulsor between today's fans and propellers. This widening scope of available propulsors is shown to offer the aircraft designer much more flexibility in powerplant selection and a better opportunity to optimalize his design. Although the primary focus is on civil aviation, wherever appropriate the commonality with military requirements has been indicated. (Author)

A71-38099 **A combustion oscillator for MHD energy conversion.** V. J. Ibberson, J. M. Beér, J. Swithenbank, D. S. Taylor, and M. W. Thring (Sheffield, University, Sheffield, England). In: Combustion Institute, Symposium (International) on Combustion, 13th, University of Utah, Salt Lake City, Utah, August 23-29, 1970, Proceedings. Symposium supported by the National Science Foundation, NSF Grant No. K-016286; the U.S. Air Force, Contract No. AF 44(620)-70-C-0075; the U.S. Navy, Contract No. N 00014-70-C-0075; NASA, Contract No. NSR-39-003-008; and the U.S. Army, Grant No. DA-ARO(D)-31-124-70-685. Pittsburgh, Combustion Institute, 1971, p. 565-572. 5 refs.

Description of an experimental combustion oscillator in which the flow of products of high-intensity combustion was modulated by a longitudinal traveling pressure wave. The heat input in the 2-in.-diam, 20-in. long combustor was 1 MW. The injector was of the water-cooled impinging type. Simultaneous measurements of pressure by Photocon pressure transducers and of electrical conductivity by a rf probe were made at two locations in the 40-in.-long combustor, at 12 and at 36 in. from the injector, in order that nonequilibrium (flame) and equilibrium types of ionization could be compared. Results showed that lean fuel/oxygen ratios and relatively low chamber pressure were favorable for promoting acoustic oscillations. On the basis of these results an experimental MHD rig was constructed with a 4-in.-diam 10-in.-long combustor equipped with an impinging jet-type injector. M.M.

A71-38901 **Society of Automotive Engineers, Intersociety Energy Conversion Engineering Conference, Boston, Mass., August 3-5, 1971, Proceedings.** Conference co-sponsored by the American Chemical Society, the American Institute of Aeronautics and Astronautics, the American Society of Mechanical Engineers, the Institute of Electrical and Electronics Engineers, the American Institute of Chemical Engineers, and the American Nuclear Society. New York, Society of Automotive Engineers, Inc., 1971. 1374 p. Members, $40.; nonmembers, $55. .

Papers covering new energy conversion techniques and equipment for spacecraft, automobiles, biomedical uses, underwater powerplants, and other applications. System designs and test data are given for solar cell arrays, Brayton-cycle spacecraft electric power systems, biomedical radioisotope thermoelectric generators, implantable fuel cells and piezoelectric converters, electric and internal-combustion automotive power systems, battery and fuel-cell underwater powerplants, fusion powerplants, and advanced fossil-fuel powerplants. New battery materials, power control concepts, ecological effects of emissions, noise and thermal pollution dangers, and problems of system reliability are considered. Extensive author and subject indexes are provided.

Individual items are abstracted in this issue. T.M.

A71-38908 * **Performance of a Brayton-cycle power conversion system using a helium-xenon gas mixture.** Alfred S. Valerino and Lloyd W. Ream (NASA, Lewis Research Center, Cleveland, Ohio). In: Society of Automotive Engineers, Intersociety Energy Conversion Engineering Conference, Boston, Mass., August 3-5, 1971, Proceedings. Conference co-sponsored by the American Chemical Society, the American Institute of Aeronautics and Astronautics, the American Society of Mechanical Engineers, the Institute of Electrical and Electronics Engineers, the American Institute of Chemical Engineers, and the American Nuclear Society. New York, Society of Automotive Engineers, Inc., 1971, p. 211-219. 14 refs.

A Brayton power conversion system was operated in an ambient environment with a gas mixture of helium and xenon. The system was operated at a compressor inlet temperature of 80 F through a compressor discharge pressure range from 20 to 45 psia and through a turbine inlet temperature range from 1300 to 1600 F. Results indicated a net engine efficiency (excluding heat losses from the heat source) of approximately 30% at a compressor discharge pressure of 45 psia and a turbine inlet temperature of 1600 F. The gross power output measured at the alternator terminals for this condition was 13.2 kW. Compressor efficiencies on the order of 79% were obtained. With the blend of helium and xenon and with high turbine inlet temperatures (1300 to 1600 F), turbine static efficiency was slightly lower than with cold argon; the values were 87.5% and 88.8% with hot helium-xenon and cold argon, respectively. T.M.

A71-38910 * **Experimental evaluation of the electrical subsystem of the 2-to-15 kW Brayton power conversion system.** R. R. Secunde, J. E. Vrancik, and A. C. Spagnuolo (NASA, Lewis Research Center, Cleveland, Ohio). In: Society of Automotive Engineers, Intersociety Energy Conversion Engineering Conference, Boston, Mass., August 3-5, 1971, Proceedings. Conference co-sponsored by the American Chemical Society, the American Institute of Aeronautics and Astronautics, the American Society of Mechanical Engineers, the Institute of Electrical and Electronics Engineers, the American Institute of Chemical Engineers, and the American Nuclear Society. New York, Society of Automotive Engineers, Inc., 1971, p. 229-238. 9 refs.

The electrical subsystem of a 1200-Hz, 2- to 15-kW Brayton power conversion system consists of the auxiliary electrical equipment required for an integrated, self-contained power conversion system. The electrical components included consist of the speed controller, alternator voltage regulator, dc power supply, batteries, two inverters, two coolant loops including the 400-Hz motor-driven pumps, and the Brayton engine control system. The electrical subsystem, powered by a motor driven alternator, was evaluated under various system operating conditions in a vacuum environment in order to determine overall performance. Overall operation of the electrical subsystem was satisfactory. Deviations of system waveforms from a true sine wave have a small but measurable effect on the performance of individual components. Operation of the speed controller has a distorting effect on the 1200-Hz system voltage. T.M.

A71-38925 * **Review of long life performance of lead telluride and silicon germanium RTG technologies.** Richard S. Caputo (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.; General Electric Co., Space Div., King of Prussia, Pa.). In: Society of Automotive Engineers, Intersociety Energy Conversion Engineering Conference, Boston, Mass., August 3-5, 1971, Proceedings. Conference co-sponsored by the American Chemical Society, the American Institute of Aeronautics and Astronautics, the American Society of Mechanical Engineers, the Institute of Electrical and Electronics Engineers, the American Institute of Chemical Engineers, and the American Nuclear Society. New York, Society of Automotive Engineers, Inc., 1971, p. 478-482.

The nominal performance of current RTG programs is reviewed and performance predictions are made for long term operation based on the most recent module data. The RTG programs which are considered for service of up to 5 or 7 years are TRANSIT (ISOTEC), PIONEER (SNAP 19-TAGS) and INTEGRAL SNAP 27 which use a

lead telluride thermoelectric material, while the multi-hundred watt (MHW) silicon germanium generator is considered for missions as long as 12 years. The MHW system using the Atomic Energy Commission's Large Isotope Heat Source for near term missions or the greater development time Helipak heat source for later missions, holds the greatest potential for future RTG application. (Author)

A71-38927 **Multihundred watt radioisotope thermoelectric generator (MHW-RTG).** A. A. Pitrolo, A. J. Arker (General Electric Co., New York, N.Y.), and R. B. Morrow (AEC, Space Nuclear Systems Div., Washington, D.C.). In: Society of Automotive Engineers, Intersociety Energy Conversion Engineering Conference, Boston, Mass., August 3-5, 1971, Proceedings.
Conference co-sponsored by the American Chemical Society, the American Institute of Aeronautics and Astronautics, the American Society of Mechanical Engineers, the Institute of Electrical and Electronics Engineers, the American Institute of Chemical Engineers, and the American Nuclear Society. New York, Society of Automotive Engineers, Inc., 1971, p. 492-511. AEC Contract No. AT (29-2)-2831.

A summary of the significant results is presented covering the period October 1969 through March 1971. This program, a systems technology effort, is developing a 'work horse' system with high efficiency and long life, applicable to a wide range of potential space missions requiring 100 to 1000 watts of electrical power. It is scheduled for flight applications beginning in the mid-1970's. Discussed in this paper are: the performance and safety requirements for the system design and development; a description and performance parameters of the SiGe converter; a description and performance characteristics of the high temperature heat source for both operational and safety considerations; an examination of the system's growth flexibility by cascading with a low temperature stage to achieve even higher conversion efficiencies; and, finally the current program development schedule. (Author)

A71-38939 **Chemical and thermal laser considered as an energy conversion system.** A. G. Hammitt (TRW Systems Group, Redondo Beach, Calif.). In: Society of Automotive Engineers, Intersociety Energy Conversion Engineering Conference, Boston, Mass., August 3-5, 1971, Proceedings. Conference co-sponsored by the American Chemical Society, the American Institute of Aeronautics and Astronautics, the American Society of Mechanical Engineers, the Institute of Electrical and Electronics Engineers, the American Institute of Chemical Engineers, and the American Nuclear Society. New York, Society of Automotive Engineers, Inc., 1971, p. 761-767.

The theory of optical energy conversion systems capable of converting thermal or chemical energy to electromagnetic radiation. In the ideal limit, the process is reversible and is subject to the usual thermodynamic limitations. Two lasing systems are described, each using gases which can be described by two temperatures: a vibrational and a translational-rotational temperature. One is a thermal system in which the energy is available from two heat sources at different temperatures. The other is a chemical system in which the energy is available from a chemical reaction. V.P.

A71-38949 **Thermionic reactor technology - An overview.** D. S. Beard (AEC, Space Nuclear Systems Office, Washington, D.C.). In: Society of Automotive Engineers, Intersociety Energy Conversion Engineering Conference, Boston, Mass., August 3-5, 1971, Proceedings. Conference co-sponsored by the American Chemical Society, the American Institute of Aeronautics and Astronautics, the American Society of Mechanical Engineers, the Institute of Electrical and Electronics Engineers, the American Institute of Chemical Engineers, and the American Nuclear Society. New York, Society of Automotive Engineers, Inc., 1971, p. 933-938. 14 refs.

An overview of the thermionic reactor technology efforts being conducted under government sponsorship in the United States is presented and the progress since the 1970 IECEC conference highlighted. The relations of the technology development approach to power system concepts for possible space and special terrestrial applications are shown. Applicability of the technology being developed for thermionics is reviewed relative to possible applications or utilization in other fields. The thermionic reactor technology programs of France, Germany and the Soviet Union are briefly reviewed and compared with the U.S. program objectives and schedule. (Author)

A71-40020 **MHD power generation.** William D. Jackson (Avco Everett Research Laboratory, Everett, Mass.). *Zeitschrift für Flugwissenschaften*, vol. 19, Aug.-Sept. 1971, p. 380-390. 38 refs.

The direct conversion of heat into electricity by means of the interaction between a flowing, electrically conducting fluid and a magnetic field has been the subject of intensive investigation in several countries for the past fifteen years. The motivation for this work has been, and continues to be, the improvement of the efficiency and performance of thermal-electric power plants. This paper reviews the basic principles of magnetohydrodynamic (MHD) power generation and reviews the status of the field as of the beginning of 1971. While emphasis is placed on open cycle MHD systems, other types are briefly described, and the environmental aspects of MHD are discussed. (Author)

A71-40898 * # **The practical use of magnetic cooling.** G. V. Brown (NASA, Lewis Research Center, Cryophysics Section, Cleveland, Ohio). *National Academy of Sciences - National Research Council, International Congress of Refrigeration, 13th, Washington, D.C., Aug. 27-Sept. 3, 1971, Paper.* 10 p. 7 refs.

Today's high-field large-volume superconducting magnets remove constraints that previously confined magnetic cooling to LHe temperatures and usually to 1 K or lower. Magnetic fields of up to 15 T can significantly order a paramagnetic system as high as about 50 K. This means that a magnetic refrigerator could be an alternative to the gas working fluid refrigerator, which has low mechanical efficiency at low temperatures. Several other devices in applied magnetic fields might be practical. These include a magnetic sorption pump for helium or hydrogen vapor, a regenerator for temperatures below 20 K, and an adjustable isothermal heat source or heat sink. The useful temperature range of some of these devices may be extended higher by using ferromagnetic materials above their Curie points. (Author)

A72-10387 **Radioisotope power systems.** *SAE Aerospace Information Report,* AIR 1213, July 30, 1971. 20 p.

Discussion of candidate radioisotope power systems which are currently in varying stages of development for aerospace applications. Radioisotope heat source requirements, nuclear radiation characteristics, factors affecting the choice of a suitable isotope, shielding specifications, safety considerations, and features of system integration with the vehicle are covered in a manner detailing principal difficulties and feasible solutions. Functional diagrams, principles of operation, and design requirements are given for thermoelectric, thermionic, Rankine cycle, and Brayton cycle energy conversion subsystems. T.M.

A72-11064 **2800 watt series inverter dc power supply.** D. L. Cronin (TRW Systems Group, Redondo Beach, Calif.). In: PCSC '71; Power Conditioning Specialists Conference, California Institute of Technology, Pasadena, Calif., April 19, 20, 1971, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1971, p. 117-123.

A high efficiency, low weight silicon controlled rectifier power supply which supplies 28V at 100A is described. The power supply operates from a conventional 3 phase 120/208Vdc (50 to 1600 Hz) power source. The AC power source is converted directly to DC

which powers two SCR inverters operating phase displaced up to 12.5 kHz. The two inverter outputs are rectified and fed into a common output filter to complete the final power conversion step. Output metering and input/output circuit breakers are provided in a rack mounted unit designed for natural convection cooling. Efficient, high frequency operation of the inverter SCR's makes possible the high overall power supply efficiency and low weight. Extremely stable and accurate voltage regulation is implemented. Additional features are inherent short circuit capability and adjustable output current limiting. Several aspects of circuit design and performance are discussed. (Author)

A72-11207 # Investigation of optimal conditions for energy conversion in an MHD generator (Issledovanie optimal'nykh uslovii preobrazovaniia energii v MGD-generatore). B. Zaporowski (Poznań, Politechnika, Poznań, Poland). *(Seminarium Poświęcone Zagadnieniom Magnetohydrodynamiki Stosowanej i Gazodynamiki Wysokich Temperatur, 3rd, Gdańsk, Poland, May 1970.) Instytut Maszyn Przepływowych, Prace,* no. 54-55, 1971, p. 77-84. 5 refs. In Russian.

The influence of plasma energy parameters on the output power of an MHD generator is analyzed under the assumption that the magnetic induction and the local electric efficiency are constants. An experimental verification of the analytical results indicates that in order to ensure high conversion efficiency, the oxidizer should be heated to 1400 K and enriched to 50% molecular oxygen. It is shown that ion seeding decreases significantly the plasma temperature, and that the maximum value of the product of the electrical plasma conductivity in the absence of a magnetic field by the square of the plasma velocity is optimal for MHD generator operation. V.P.

A72-14376 * # What can nuclear energy do for society. F. E. Rom (NASA, Lewis Research Center, Cleveland, Ohio). *American Institute of Aeronautics and Astronautics, Symposium on Uranium Plasmas: Research and Applications, 2nd, Atlanta, Ga., Nov. 15-17, 1971, Paper.* 24 p. 12 refs.

Nuclear fuel is a compact and abundant source of energy. Its cost per unit of energy is less than that of fossil fuel. Disadvantages of nuclear fuel are connected with the high cost of capital equipment required for releasing nuclear energy and the heavy weight of the necessary shielding. In the case of commercial electric power production and marine propulsion the advantages have outweighed the disadvantages. It is pointed out that nuclear commercial submarines have certain advantages compared to surface ships. Nuclear powerplants might make air-cushion vehicles for trans-oceanic ranges feasible. The problems and advantages of a nuclear aircraft are discussed together with nuclear propulsion for interplanetary space voyages. G.R.

A72-15696 # Reliability of converter networks of thermionic power supply equipments (Zuverlässgkeit der Konverternetzwerke von thermionischen Energieversorgungsanlagen). S. Dagbjartsson. Stuttgart, Universität, Institut für Kernenergetik, Dr.-Ing. Dissertation, 1970. 72 p. 24 refs. In German.

Taking into account the current-voltage characteristics of thermionic converters, the current and voltage values characteristic of the individual branches of a network are examined, particular attention being given to the failure of individual converters. The failure is considered to be a statistical event that occurs with equal probability in all converters during the operation of a converter network. This formalism makes it possible to calculate the network reliability as a function of the possible excess output at the beginning of the operation period. It has been found that the probability of failure of any converter is 5%, and that the emitter temperature of some converters, which is initially about 1860 K, exceeds with a probability of about 10% the temperature of 2000 K. O.H.

A72-15940 # 'Unitized' thermoelectric module concept. P. E. Eggers (Battelle Columbus Laboratories, Columbus, Ohio). *American Society of Mechanical Engineers, Winter Annual Meeting, Washington, D.C., Nov. 28-Dec. 2, 1971, Paper 71-WA/Ener-1.* 11 p. 11 refs. Members, $1.00; nonmembers, $3.00.

This paper discusses a novel approach to the design and qualification of radioisotope thermoelectric generators. This approach, which involves hermetically sealed bellows-encapsulated thermoelectric elements, features not only the potential for greatly increased generator output power stability and reliability, but also the advantages of a standardized approach to generator design, fabrication, and qualification. All aspects of the proposed concept draw on presently available technology, including the utilized heat source design. (Author)

A72-16745 Power supply and power converters in satellites and spacecraft (Energieversorgung und Energiewandler in Satelliten und Raumfahrzeugen). W. Peschka (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Energiewandlung und elektrische Antriebe, Stuttgart, West Germany). *VDI-Z,* vol. 113, Dec. 1971, p. 1451-1453. 51 refs. In German.

Review of recent advances made in the development of power sources and converters for use in satellites and spacecraft. Recent achievements in the development of batteries and fuel cells, radioisotopes, and nuclear reactors are discussed, as well as new developments in the design of solar cells and mechanoelectric, thermoelectric, thermionic, and inductive fluid dynamic converters. A.B.K.

A72-16936 * # Status of power generation experiments in the NASA Lewis closed-cycle MHD facility. R. J. Sovie and L. D. Nichols (NASA, Lewis Research Center, Plasma Power Generation Section, Cleveland, Ohio). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-103.* 8 p. 8 refs. Members, $1.50; nonmembers, $2.00.

In this paper the design and operation of the closed-cycle MHD facility is discussed and results obtained in recent experiments are presented. The main components of the facility are a compressor, recuperative heat exchanger (preheater), heater, nozzle, MHD channel with 28 pairs of thoriated tungsten electrodes, cesium condenser, and an argon cooler. The heater can supply 1.1 MW of thermal power to a 2.27 kg/sec gas stream. The facility has been operated at temperatures up to 2100 K with a cesium-seeded argon working fluid. At low magnetic field strengths ($B = 0.2$ T), the open circuit voltage, Hall voltage and short circuit current obtained are 90, 69, and 47 percent of the theoretical equilibrium values, respectively. The Hall voltage and short circuit current decrease sharply with increasing magnetic field strength, however. Comparison of these data with a wall and boundary layer leakage theory indicates that the generator has shorting paths in the Hall direction. (Author)

A72-17304 * Minimum-energy control of a class of electrically driven vehicles. Y. E. Sahinkaya and R. Sridhar (Control Data Corp., Los Angeles, Calif.). *IEEE Transactions on Automatic Control,* vol. AC-17, Feb. 1972, p. 1-6. 6 refs. NASA-sponsored research.

A minimum-energy controller is designed and built for a class of electrically driven vehicles according to the theoretical concepts determined by the application of modern control theory. Theoretical results are obtained by making several justifiable assumptions in the dynamical equations of the system and solving the resulting stochastic optimal control problem by Bellman's dynamic programming technique. Several practical and economical considerations are taken into account for the mechanization of the minimum-energy control law. (Author)

A72-18290 Controlling the input of the reactants in hydrazine-oxygen fuel cell aggregates (Regelung der Zufuhr der Reaktanten bei Hydrazin-Sauerstoff-Brennstoffzellenaggregaten). H. Kohlmüller (Siemens AG, Forschungslaboratorien, Erlangen, West

Germany). *Messtechnik*, vol. 79, Dec. 1971, p. 290-293. 7 refs. In German. Research supported by the Bundesministerium für Verteidigung.

Demonstration that a quasi-continuous supply of reactants for hydrazine-oxygen fuel cells can be ensured by means of pulse-controlled solenoids, thereby increasing the efficiency of the plant. The long response time of the hydrazine sensor cell results in a control loop of sufficiently fast response to adapt the hydrazine feed to load fluctuations only in conjunction with a proportional-plus-integral controller with the load as the perturbation variable. The short response time of the oxygen sensors to an insufficient supply of oxygen results in a control loop in which only slight oxygen losses occur if used in conjunction with a proportional controller. A.B.K.

A72-18336 **Self-regenerating molten-seed electrodes for magnetohydrodynamic power generators.** B. Warszawski (Société Générale de Constructions Electriques et Mécaniques Alsthom, Massy, Essonne, France). *Energy Conversion*, vol. 12, Mar. 1972, p. 25-29.

Description of a projected electrode system conceived as a possible contribution to the problem of extending the useful life of open cycle MHD generators. It is shown that the use of self-regenerating molten-seed electrodes in MHD power generators makes it possible to inject active seed into the coldest regions of the gas flow where it is needed most and to reduce the main seeding in the combustion chamber. M.V.E.

A72-21275 **Soviet civil gas turbine engines.** *Interavia*, vol. 27, Feb. 1972, p. 158-161.

Review of Soviet gas turbine engine construction and performance on the basis of available published information and external characteristics. According to Soviet reports, turbojet, turboprop, and turboshaft engines installed in Aeroflot aircraft have proved extremely reliable. They are designed specifically for domestic air transport requirements and for the climatic conditions encountered in the country. Recent developments indicate that there is a tendency to replace turboprops by turbojets for medium and short range routes. Compared with Western engines, it appears that Soviet engines have relatively high rates of fuel consumption. Technical data for Soviet engines are tabulated. F.R.L.

A72-21414 **A kilowatt rotary power transformer.** S. H. Marx (Philco-Ford Corp., Palo Alto, Calif.) and R. W. Bounds (COMSAT Laboratories, Clarksburg, Md.). *(Institute of Electrical and Electronics Engineers, Power Conditioning Specialists Conference, California Institute of Technology, Pasadena, Calif., Apr. 19, 20, 1971.) IEEE Transactions on Aerospace and Electronic Systems*, vol. AES-7, Nov. 1971, p. 1157-1163. Research supported by the Communications Satellite Corp.

This paper describes the development of a rotary transformer for typical spacecraft applications. The transformer is built in modular sections, each capable of transferring 500 W across a gap at efficiencies greater than 88%, dc to dc. The design effort included a study of pertinent electrical characteristics required for typical spacecraft configurations, electrical design and analyses of the overall dc-dc converter, mechanical design of the transformer cores and their assembly, and a study of transformer core and winding characteristics. Breadboard test results have demonstrated the desired level of efficiency, satisfactory operation over temperature, and satisfactory electrical characteristics. (Author)

A72-22401 **Electrode and insulation materials in magnetohydrodynamic generators.** L. L. Fehrenbacher and N. M. Tallan (USAF, Aerospace Research Laboratories, Wright-Patterson AFB, Ohio). In: Ceramics in severe environments; Proceedings of the Sixth University Conference on Ceramic Science, North Carolina State University, Raleigh, N.C., December 7-9, 1970. (A72-22376 09-18) New York, Plenum Press, 1971, p. 503-518; Discussion, p. 519, 520. 35 refs.

The operation and service environment of open and closed cycle MHD generators is described. The performance characteristics of candidate electrode and insulation materials and their peculiar limitations with respect to conductivity, mechanical and electrochemical erosion, thermal shock resistance, maximum allowable surface temperature, compositional stability (polarization and contamination), thermionic emission, and overall service life are discussed. Special emphasis is given to problems associated with the performance of various ceramic insulators and electrodes used in open cycle generators. Recommendations for research studies on specific ceramic compositions and systems showing potential as MHD generator channel materials are offered. (Author)

A72-23684 **Goals and trends in heat transfer research.** E. R. G. Eckert (Minnesota, University, Minneapolis, Minn.). *Wärme- und Stoffübertragung*, vol. 5, no. 1, 1972, p. 3-8. 12 refs.

Heat transfer research is instigated primarily by new developments in technology. In the last thirty years, the fields of gas turbines, aeronautics, astronautics, and nuclear power contributed many problems for basic heat transfer studies. These are discussed, and presently unsolved problems are enumerated. In recent years, thermal pollution and the possibility to achieve controlled fusion posed new challenges for heat transfer research. (Author)

A72-24700 **Fuel cells.** D. P. Gregory (Institute of Gas Technology, Chicago, Ill.). London, Mills and Boon, Ltd. (M & B Monograph, No. CE/7), 1972. 70 p. 19 refs. $3.90.

Condensed outline of fuel cell technology, principles of operation, and applications. The thermodynamics of fuel cells and principles of electrode polarization are dealt with simply, and the requirements for a complete fuel cell system are outlined. Various types of fuel cells are described and classified, with particular attention to systems which have found practical applications. Some of the problems still to be solved are examined. F.R.L.

A72-25629 # **Design and test evaluation of a liquid metal regenerator for gas turbines.** S. Moskowitz and J. Horvath (Curtiss-Wright Corp., Wood-Ridge, N.J.). *American Society of Mechanical Engineers, Gas Turbine and Fluids Engineering Conference and Products Show, San Francisco, Calif., Mar. 26-30, 1972, Paper 72-GT-33.* 12 p. Members, $1.00; nonmembers, $3.00. Contract No. NOw-66-0738-a.

Description of a lightweight regenerator for a 4000-shp turboshaft engine in which liquid NaK is used as the heat transport fluid for heat transfer from the turbine discharge gas to the compressor discharge air. The regenerator design includes an exhaust gas-to-metal heat exchanger, a metal-to-compressor air heat exchanger, and a rotary liquid-metal induction pump, forming a single hermetically sealed liquid metal circuit. The results of an analytical study of the system and of performance and durability simulation tests are given and are compared with theoretical predictions. Special system component production methods are also described. V.Z.

A72-27721 **A technique for determining the operational characteristics of a thermoelectric module.** H. Y. Wong (Glasgow, University, Glasgow, Scotland) and W. Shakun (Torin Corp., Torrington, Conn.). *Energy Conversion*, vol. 12, June 1972, p. 41-44.

Description of a testing apparatus and technique for assessing the operational characteristics of a Peltier device for cooling. The technique makes it possible to obtain true characteristics, and indicates where improvement of the device performance can be obtained from the engineering standpoint. It gives reliable and repeatable results over the heat sink temperature range between 50 and -20 C. O.H.

A72-27722 **Practical limits to the thermoelectric figure of merit. II.** R. W. Ure, Jr. (Utah, University, Salt Lake City, Utah). *Energy Conversion*, vol. 12, June 1972, p. 45-52. 43 refs.

Upper limits on the figure of merit of materials for thermoelectric devices are derived using experimental values of the parameters on a wide variety of semiconducting materials. These results show that the practical maximum figure of merit is considerably smaller than the earlier proposed theoretical maximum. O.H.

A72-27724 **The potential role of jet compression in high temperature energy conversion.** G. Angelino (Milano, Politecnico, Milan, Italy). *Energy Conversion*, vol. 12, June 1972, p. 69-75. 6 refs.

Discussion of the potential performance of a purely mechanical energy exchanger capable of reducing substantially the stagnation temperature of the working medium with limited losses, transferring the useful energy to a comparatively cold fluid flow. The exchanger is based on the ejector principle, and can operate either in combination with a MHD generator or, at lower temperatures, with mechanical expanders. O.H.

A72-29351 **Symposium on the Engineering Aspects of Magnetohydrodynamics, 12th, Argonne, Ill., March 27-29, 1972, Proceedings.** Symposium sponsored by the Argonne National Laboratory and University of Illinois. Edited by M. Petrick (Argonne National Laboratory, Argonne, Ill.). University, Miss., University of Mississippi, 1972. 376 p. $15.

The papers are short reports dealing with work currently in progress. These include studies of nonequilibrium generators, combustion generators, plasma properties and diagnostics, liquid-metal MHD, plasma instabilities, MHD components, and system studies.

Individual items are abstracted in this issue. F.R.L.

A72-29353 # **The effects of electrode configuration on the performance of a Faraday type MHD generator.** J. W. M. A. Houben, J. H. Blom, and L. H. Th. Rietjens (Eindhoven, Technische Hogeschool, Eindhoven, Netherlands). In: Symposium on the Engineering Aspects of Magnetohydrodynamics, 12th, Argonne, Ill., March 27-29, 1972, Proceedings. University, Miss., University of Mississippi, 1972, p. I.3.1-I.3.6. 10 refs.

The influence of the electrode configuration on the performance of a linear, nonequilibrium, Faraday type MHD generator has been studied theoretically. Numerical, two-dimensional, calculations are carried out for a number of electrode configurations. In the mathematical model nonequilibrium ionization and relaxation effects in electron temperature and density are included. The velocity and temperature profiles are postulated. The Ar-Cs plasma conditions are taken from the Eindhoven shocktube experiment. The influence of electrode configuration with respect to voltage drops, axial leakages, emission problems and internal resistance is discussed. Comparison of flat electrodes in the generator wall with rod electrodes out of this wall results in a preference for the rod electrode configuration. (Author)

A72-29354 # **Influence of ionization turbulence on the performance of nonequilibrium plasma MHD generators.** V. Zampaglione (Comitato Nazionale per l'Energia Nucleare, Laboratorio Conversione Diretta, Frascati, Italy). In: Symposium on the Engineering Aspects of Magnetohydrodynamics, 12th, Argonne, Ill., March 27-29, 1972, Proceedings. University, Miss., University of Mississippi, 1972, p. I.4.1-I.4.5. 12 refs.

It is shown that the evaluations of the performance of nonequilibrium plasma generators, which are still currently based on approximate turbulent plasma equations, can lead to substantial inaccuracies. A correct evaluation of the effect of ionization turbulence on the performance of these generators is presented. Equations for current-voltage characteristics are derived and compared with experimental data. O.H.

A72-29355 # **Progress in analytical modeling of MHD power generators.** S. T. Demetriades, G. S. Argyropoulos, and C. D. Maxwell (STD Research Corp., Pasadena, Calif.). In: Symposium on the Engineering Aspects of Magnetohydrodynamics, 12th, Argonne, Ill., March 27-29, 1972, Proceedings. University, Miss., University of Mississippi, 1972, p. I.5.1-I.5.13. 19 refs. Contract No. F44620-70-C-0001.

A realistic analytical method of modeling MHD power generators has been developed, that has the ability (1) to give accurate quantitative prediction of the performance and efficiency of a generator channel as a function of its size, and (2) to dictate the choice of operating conditions and geometry that will optimize the efficiency and longevity of an MHD generator of a given size. The modeling is performed by numerical (digital) techniques. The local behavior at every point of an MHD channel is computed as a function of time by a unique solution, and the field distributions are then integrated to derive the overall performance characteristics. The effect of each one (or any combination) of the important physical mechanisms is investigated separately. This method has been applied to existing real-life devices and has given excellent agreement with the experimental results. It can be used as a practical engineering tool for predicting the overall performance and optimizing the design parameters of both open-cycle and closed-cycle MHD power generators before they are built. (Author)

A72-29356 # **Electrode effects and gas dynamic characteristics of a large, non-equilibrium MHD generator with cesium seeded, noble gases.** B. Zauderer and E. Tate (GE Space Sciences Laboratory, King of Prussia, Pa.). In: Symposium on the Engineering Aspects of Magnetohydrodynamics, 12th, Argonne, Ill., March 27-29, 1972, Proceedings. University, Miss., University of Mississippi, 1972, p. I.6.1-I.6.10. 16 refs. Navy-supported research.

An experimental study was performed to determine the factors limiting the power output of a linear, supersonic Faraday generator, having electrodes suspended in the gas flow. The test gases were cesium seeded neon or argon at 2000 to 4000 K stagnation temperatures and 5 to 11 MW thermal power levels. It was observed that the electrode current varies directly with the cesium concentration for electrode current densities of the order of tens of amp/sq cm. The electrode current was nearly independent of electrode temperature and surface area. It was concluded that the electrode conduction was due to the cesium ion flux at the cathode, and that 20% heat to electric conversion should be readily attainable by using a larger MHD channel or by operating at higher gas pressures, cesium concentrations, and magnetic field strengths. M.V.E.

A72-29364 # **Recent experimental results from a one-wavelength MHD induction generator.** E. S. Pierson (Illinois, University, Chicago, Ill.). In: Symposium on the Engineering Aspects of Magnetohydrodynamics, 12th, Argonne, Ill., March 27-29, 1972, Proceedings. University, Miss., University of Mississippi, 1972, p. IV.2.1-IV.2.5. 9 refs.

An experimental one-wavelength-long MHD induction generator has been operated successfully on a NaK flow system with a variety of excitation conditions, including tests both with and without compensating poles. The experimental generator is described briefly. A Fourier series method of calculating the magnetic flux density, discussed previously, is extended to include power calculations. Initial results from over 200 data points are summarized, with detailed analysis to follow. (Author)

A72-29365 * # **Numerical analysis method for linear induction machines.** D. G. Elliott (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Symposium on the Engineering Aspects of Magnetohydrodynamics, 12th, Argonne, Ill., March 27-29, 1972, Proceedings. University, Miss., University of Mississippi, 1972, p. IV.3.1-IV.3.9. 12 refs.

A numerical analysis method has been developed for linear induction machines such as liquid metal MHD pumps and generators and linear motors. Arbitrary phase currents or voltages can be specified and the moving conductor can have arbitrary velocity and conductivity variations from point to point. The moving conductor is divided into a mesh and coefficients are calculated for the voltage induced at each mesh point by unit current at every other mesh point. Combining the coefficients with the mesh resistances yields a set of simultaneous equations which are solved for the unknown currents. (Author)

A72-31375 **Characterizing thermoelectric generators.** G. E. Guazzoni (U.S. Army, Electronics Technology and Devices Laboratory, Fort Monmouth, N.J.). *Instruments and Control Systems,* vol. 45, May 1972, p. 85-87.

During the past twenty years, properties of semiconductor materials such as PbTe, SiGe, and Bi2Te3 have been improved to the extent that thermoelectricity offers a practical means of power generation in some applications. Thermoelectrical principles are reviewed. The capability of a thermopile to convert applied heat to electric power depends strongly on the value of the internal resistance. The use of the effective working resistance as a performance parameter is considered. Parameters were evaluated at 40 to 50 hour intervals during a test, to obtain a continuous characterization of converter performance. G.R.

A72-32994 # **Thermodynamics of systems directly converting chemical energy into electric energy (K termodinamike sistem priamogo preobrazovaniia khimicheskoi energii v elektricheskuiu).** V. A. Grodko and B. N. Markar'ian. *Akademiia Nauk SSSR, Izvestiia, Energetika i Transport,* Mar.-Apr. 1972, p. 150-159. 5 refs. In Russian.

Theoretical consideration of a reversible thermodynamic cycle for ideal direct chemical-to-electric energy conversion using electron gas as the working body. It is shown that the Gibbs-Helmholtz equations and some analogs of isotherm and isobar equations describe the behavior of electron gas in this application. Expressions are given to determine the performance characteristics of the associated electrochemical and thermoelectrochemical systems. Similarity of thermodynamic aspects is established for chemical-to-electric energy conversion systems and thermal-to-electric conversion systems. V.Z.

A72-33876 **From electrocatalysis to fuel cells; Proceedings of the Seminar, Seattle, Wash., December 9-11, 1970.** Edited by G. Sandstede (Battelle-Institut, Frankfurt am Main, West Germany). Seattle, University of Washington Press, 1972. 413 p. $12.50.

The papers deal with research and development work performed for the entire field of fuel cells, with emphasis on the results of research on electrocatalysts. Included are discussions of the state of the art of fuel cell technology for a variety of fuel cell systems. Results obtained for secondary battery systems are used to compare the properties and applications of various energy conversion devices in the light of the last findings, and to discuss in what way and to what extent fuel cells and secondary batteries can supplement each other. Much attention is given to new organic and inorganic electrocatalysts and to electrotraction and implantable fuel cells.

Individual items are abstracted in this issue. V.P.

A72-33887 **Outlook for alkaline fuel cell batteries.** K. V. Kordesch (Union Carbide Corp., Parma, Ohio). In: From electrocatalysis to fuel cells; Proceedings of the Seminar, Seattle, Wash., December 9-11, 1970. Seattle, University of Washington Press, 1972, p. 157-164. 19 refs.

The present status and trends of alkaline cells are reviewed on the basis of published military contracts and industrial work during 1969-70. It is shown that carbon dioxide removal from the air is easy, and that the resulting improvements warrant the expense. This makes the alkaline system a preferred choice, in particular, in the presence of a simple means of shutting down and starting up the fuel cell systems to provide long life expectancies, even on intermediate duty cycles. Applications ranging from portable batteries to vehicle power systems are examined. V.P.

A72-34583 * **Detailed design of a 100-We multicell thermionic power supply.** P. Rouklove (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.) and J. G. DeSteese (Donald W. Douglas Laboratories, Richland, Wash.). In: Annual Thermionic Conversion Specialist Conference, 10th, San Diego, Calif., October 4-6, 1971, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1971, p. 59-67. 5 refs.

Confirmation of the general trends of a previously reported parametric study of plutonia-fueled thermionic generators in a detailed 100-We generator design. The detailed design takes into account the additional weight of system-integration components and shows that design refinements of all aeroshell components are possible when a specific generator configuration is considered. An optimized 100-We thermionic power supply design is presented, reflecting a 0.98 reliability goal after five years of operation. The optimum multicell array consists of 28 isomite converters, each producing approximately 3.6 We at end-of-life. The optimum arrangement of converters in the aeroshell is a four-column, seven-row stacking configuration connected electrically as a two-column, 14-row array. (Author)

A72-34603 **Thermionic energy conversion with a Ba-Cs-diode.** R. Henne (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Energiewandlung und Elektrische Antriebe, Stuttgart, West Germany). In: Annual Thermionic Conversion Specialist Conference, 10th, San Diego, Calif., October 4-6, 1971, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1971, p. 212-219. 7 refs.

The program of the Thermionic-group of the Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt in Stuttgart is discussed. Experiments with Ba-Cs-diodes and some important problems involved in the use of barium and their solutions in our laboratory are described. Results obtained with a plane Ba-Cs thermionic converter with polycrystalline molybdenum electrodes with variable spacing and the conclusions for future works are represented. (Author)

A72-34604 **Output performance of a thermionic converter with an oriented tungsten /110/ emitter and a polycrystalline tungsten collector.** V. C. Wilson (General Electric Co., Schenectady, N.Y.). In: Annual Thermionic Conversion Specialist Conference, 10th, San Diego, Calif., October 4-6, 1971, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1971, p. 220-224. 7 refs. Contract No. AT(04-3)-771.

Measurements were made of the power generated by a parallel plane thermionic converter with an oriented tungsten (110) emitter and a polycrystalline tungsten collector. The emitter had a vacuum work function of 5.06 eV. Curves have been made to compare the output of this converter with that of converters with identical emitters but collectors of Nb and Ni. With emitter temperatures from 1750 to 2150 K the converter with the W collector averaged about 8% more output power than the converter with the Nb collector. However, the converter with the Ni collector produced about 17% more power than the converter with the Nb collector. (Author)

A72-36139 # **Summary of six years of converter tests in the laboratory (Bilan de six années d'essais de convertisseurs au laboratoire).** M. Clemot, B. Gayte, and J. Tripet (Commissariat à

l'Energie Atomique, Centre d'Etudes Nucléaires de Saclay, Gif-sur-Yvette, Essonne, France). *International Atomic Energy Agency and European Nuclear Energy Agency, International Conference on Thermionic Electrical Power Generation, 3rd, Jülich, West Germany, June 5-9, 1972, Paper.* 16 p. 9 refs. In French.

Results of a series of laboratory tests of the lifetime, performance and stability of thermionic converters. The test stands and measurement systems employed are described, and the characteristics of the converters tested are briefly cited. Test results are presented which deal with the causes of converter stoppage, the behavior of the emitters, the behavior of the collectors, the metal-ceramic seals, the cesium consumption in thermionic materials, the effect of gases contained in the collector material or present in the electrode gap on the performance stability, and the effect of mutual diffusion of molybdenum and tungsten in the emitter on this stability. A.B.K.

A72-36166 # **Applications for incore-thermionic-reactors.** W. Rasch (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Braunschweig, West Germany). *International Atomic Energy Agency and European Nuclear Energy Agency, International Conference on Thermionic Electrical Power Generation, 3rd, Jülich, West Germany, June 5-9, 1972, Paper.* 15 p. 10 refs.

Consideration of the feasibility of using in-core thermionic reactors to meet future power requirements in Europe. The steady increase in power requirements for applications satellites and for submarines and underwater laboratories is noted, and an attempt is made to extrapolate these requirements to determine future needs of West Germany and Europe as a whole. Possible alternate sources of higher power are reviewed, including solar cell generators, thermoelectric and thermionic converters, and Rankine- or Brayton-cycle turbines. It is concluded that in comparison with other nuclear systems the in-core thermionic reactor is technically the best solution and the system with the greatest potential for further development. A possible application of the in-core thermionic reactor in a European TV broadcasting satellite is considered, and estimated development costs are cited. A.B.K.

A72-36192 # **The maximum attainable efficiency of thermionic converters.** K. Urbaniec (Warszawa, Politechnika, Warsaw, Poland). *International Atomic Energy Agency and European Nuclear Energy Agency, International Conference on Thermionic Electrical Power Generation, 3rd, Jülich, West Germany, June 5-9, 1972, Paper.* 11 p. 9 refs.

Differences between efficiency concepts based on different definitions are analyzed, taking into account the over-all efficiency, the intrinsic efficiency, and the electron efficiency. It is found that only the over-all efficiency has any significance for questions of energy conversion in connection with a comparison between thermionics and other conversion techniques. The theoretical limits of the over-all efficiency are investigated together with the optimum values for the parameters employed in converter design and operation. G.R.

A72-36332 **Pulsed power - A new technology for controlled thermonuclear fusion.** L. S. Levine (U.S. Navy, Naval Research Laboratory, Washington, D.C.). In: Scanning the spectrum; Proceedings of the Tenth Annual Region 3 Convention, Knoxville, Tenn., April 10-12, 1972. New York, Institute of Electrical and Electronics Engineers, Inc., 1972, p. Q1-1 to Q1-7. 43 refs. Research supported by the Defense Nuclear Agency and U.S. Navy.

The development of pulsed power technology has now reached the point where it may be able to make a significant contribution to the quest for controlled thermonuclear fusion. Existing pulsed power generators can produce powers of the order of 1 TW for times of the order of .1 microsec. Such generators are most commonly utilized to produce intense relativistic electron beams, and this paper briefly surveys the existing state of the art of generators and relativistic beams. The paper also considers several of the methods that have been proposed for incorporating intense beams or pulsed plasma generators into controlled fusion schemes. (Author)

A72-36558 **A turbine can power your pump.** H. J. Dickinson (Martin Marietta Corp., Houston, Tex.). *Hydraulics and Pneumatics,* vol. 25, July 1972, p. 95-97.

A hot-gas turbine is an alternative to the electric-motor-driven pump power source. The turbine can be driven by cold gas for long periods of time prior to hot-gas operation. The component parts consist of pressure regulating valves, igniters, speed control, output shaft, axial-flow turbine wheel, and housing. Turbine speed may be regulated by parasitic load control supplied by a separate electric generator. The characteristics of liquid fuel systems and solid propellant systems are discussed together with a turbine system which combines ram air and a hot gas turbine. Continuous standby power may be supplied by driving the impulse turbine with ram air. G.R.

A72-39940 **Energy-direct conversion today. II (Energie-Direktumwandlung heute. II).** K. J. Euler (Gesamthochschule, Kassel, West Germany). *VDI-Z,* vol. 114, no. 11, Aug. 1972, p. 784-789. 27 refs. In German.

Thermionic reactors are considered, giving attention mainly to developments in the Federal Republic of Germany. Thermionic converters are basically electron tubes with an externally heated cathode and an externally cooled anode. Electrons emitted at about 2000 K from the cathodes, the emitter, pass to the collector, which has a temperature of 900 K. Thermoelectric current sources are gas-heated thermoelements consisting of p-ZnSb and Ni. Thermoelectric current sources are used for applications in the areas of communications, meteorology, geophysics, oceanography, and space exploration. Systems for nuclear auxiliary power systems are also discussed, taking into account their general design, operational principles, economic factors, and a thermoelectric nuclear system brought to the lunar surface in the Apollo 12 mission. G.R.

A72-43148 * # **Some contributions to energetics by the Lewis Research Center and a review of their potential non-aerospace applications.** R. W. Graham and M. U. Gutstein (NASA, Lewis Research Center, Cleveland, Ohio). *American Society of Mechanical Engineers, Aerospace Conference, Anaheim, Calif., Sept. 10-13, 1972, Paper 72-Aero-12.* 9 p. 52 refs. Members, $1.00; nonmembers, $3.00.

A72-43723 **Laser-produced plasma and fusion yield.** L. S. Dzung (Brown Boveri et Cie. AG, Baden, Switzerland). *Zeitschrift für angewandte Mathematik und Physik,* vol. 23, Mar. 25, 1972, p. 301-310. 8 refs.

Lubin and Fraas (1971) have reported an engineering approach for utilizing for electrical power generation a method of plasma production which is based on the heating of small pellets of fusionable material by laser radiation. In this approach the fusion energy is absorbed as thermal energy by liquid lithium. The lithium provides the heat source for a conventional power plant. One of the crucial questions regarding this approach is concerned with the required energy of the laser pulse. The results produced by various previous investigations of the question show great differences. The problem is carefully analyzed, taking systematically into account the effects of changing parameters. A gasdynamic model combining reasonable physical accuracy with sufficient mathematical simplicity is discussed. G.R.

A72-45179 * # **United States Space Nuclear Electric Power Program.** G. A. Newby (AEC-NASA, Washington, D.C.). *International Astronautical Federation, International Astronautical Congress, 23rd, Vienna, Austria, Oct. 8-15, 1972, Paper.* 22 p. 6 refs.

The principal characteristics and design features of major systems and technological developments in U.S. space nuclear power activities are reviewed, covering radioisotope thermoelectric generators, reactor space electric power technology, and the advanced liquid metal cooled power reactor program. The topics also include heat source design and development, thermoelectric efficiency, high performance thermoelectric materials, and alloy developments. The U.S. Space Electric Power Program is described as one aimed at the development of a minimum number of standard components and power modules for both radioisotopes and reactor systems that will meet the widest possible range of future requirements. The need to reduce the high cost of the isotopic generators already used in space missions is stressed. V.Z.

A73-10434 # **Effect of heterogeneity and Hall current on the MHD power generator.** N. Rudraiah, S. N. Murthy, and B. C. Chandrasekhara (Visvesvaraya College of Engineering, Bangalore, India). *Japanese Journal of Applied Physics,* vol. 11, Sept. 1972, p. 1372-1379. 13 refs.

A73-10616 # **Certain problems in creating superconducting magnetic systems (Nekotorye problemy sozdaniia sverkhprovodiashchikh magnitnykh sistem).** V. V. Sychev. *Akademiia Nauk SSSR, Izvestiia, Energetika i Transport,* July-Aug. 1972, p. 39-49. 11 refs. In Russian.

Detailed analysis of certain problems involved in ensuring reliable operation of superconducting magnetic systems. The advantages of superconducting magnetic systems over ordinary electromagnets are outlined, and problems involved in designing large superconducting magnetic systems are indicated. Particular attention is paid to the problem of preventing damage to the winding of a superconducting magnetic system through uncontrolled transition of the winding into the normal state. The use of a combination conductor to ensure stabilization of the superconducting state is described. A.B.K.

A73-11826 * **Applied Superconductivity Conference, 5th, Annapolis, Md., May 1-3, 1972, Proceedings.** Conference sponsored by the National Science Foundation, NASA, Institute of Electrical and Electronics Engineers, American Institute of Physics, and U.S. Navy. New York, Institute of Electrical and Electronics Engineers, Inc., 1972. 746 p. $20.

Recently developed practical applications of superconductivity are described in papers dealing with transportation and propulsion, power generation, power transmission, special-purpose magnets, superconducting materials, Josephson junctions, and microwave systems. Important topics considered include tracked magnetic-cushion vehicles, electrical machines, cryogenic underground power transmission systems, magnets for fusion reactors and particle accelerators, thin-film superconductors, effects of the structural characteristics of materials on transition temperatures, frequency measurement with Josephson devices, and superconducting scientific instruments.

T.M.

A73-11828 **Superconducting considerations in rotating electrical machines.** Z. J. J. Stekly (Magnetic Corporation of America, Cambridge, Mass.). In: Applied Superconductivity Conference, 5th, Annapolis, Md., May 1-3, 1972, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1972, p. 47-56. 14 refs. USAF-supported research.

This paper deals with the problems associated with superconducting field windings. The basic requirements for the field are discussed in terms of size, magnetic energy stored, power level, speed of rotation, number of poles. While the field winding is basically dc in nature, it is exposed to time varying magnetic fields and forces due to the armature currents generated by loading transients, faults, unbalanced electrical loads, as well as load generated harmonics. The effect of these on the design of the field as well as on the performance of the superconductor is discussed. (Author)

A73-11833 **A review of the critical aspects of superconducting a.c. generators.** A. D. Appleton and A. F. Anderson (International Research and Development Co., Ltd., Newcastle-upon-Tyne, England). In: Applied Superconductivity Conference, 5th, Annapolis, Md., May 1-3, 1972, Proceedings.
New York, Institute of Electrical and Electronics Engineers, Inc., 1972, p. 136-144. 7 refs.

The development of superconducting ac generators to meet future demands for electrical power is examined in terms of conversion efficiency, required manufacturing processes, and relative costs as compared to conventional turbogenerator machines. The critical aspects of superconducting ac generators are reviewed, using a 500-MW rating as the basis of comparison with conventional machines. The influence of machine geometry on the performance characteristics is outlined, with particular attention devoted to the effects of interwinding coupling factors. Principal mechanisms leading to machine losses are identified along with techniques used for their prediction and minimization. T.M.

A73-13388 * # **Design point characteristics of a 500 - 2500 watt isotope-Brayton power system.** G. J. Barna (NASA, Lewis Research Center, Cleveland, Ohio). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Specialist Conference, 8th, New Orleans, La., Nov. 29-Dec. 1, 1972, AIAA Paper 72-1059.* 8 p. 5 refs. Members, $1.50; nonmembers, $2.00.

An analytical study was conducted to investigate the potential performance characteristics of an isotope-Brayton space power system at electric power levels from 500 to 2500 W. Utilization of the Pu 238 heat source, or capsule, being developed for the Multi-Hundred Watt Radioisotope Thermoelectric Generator was assumed. A single-loop system design concept was selected. The design concept and results of first-order tradeoff studies of the effects of major system parameters on system performance are presented. Results of the study indicate the potential for high system efficiency and high specific power over the entire power range.

(Author)

A73-15118 # **High temperature fuel cell system for the conversion of methane.** R. Steiner, F. J. Rohr, and W. Fischer (Brown, Boveri et Cie. AG, Heidelberg, West Germany). In: International Symposium on Fuel Cells, 4th, Antwerp, Belgium, October 2, 3, 1972, Proceedings. Volume 1. Mol, Belgium, Commissariat de l'Energie Atomique, 1972. 22 p. 7 refs. Research supported by the Bundesministerium für Bildung und Wissenschaft.

High temperature zirconium dioxide electrolyte fuel cell systems are now at a state of development, where the problems concerning single cells are solved and where the voltage and the efficiency as a function of the output power are known. In this paper, fuel cell system characteristics are evaluated from these single cell quantities and some conclusions are drawn concerning possible applications.

(Author)

A73-16586 # **Analysis of optimal conditions for energy conversion in an MHD-generator channel (Analiz optimal'nykh uslovii preobrazovaniia energii v kanale MGD-generatora).** E. V. Nazarov. *Magnitnaia Gidrodinamika,* July-Sept. 1972, p. 6-13. 13 refs. In Russian.

A73-16980 # **Engineering problems in the design of controlled thermonuclear reactors.** A. P. Fraas (Oak Ridge National Laboratory, Oak Ridge, Tenn.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 11th, Washington,*

D.C., Jan. 10-12, 1973, Paper 73-259. 8 p. 20 refs. Members, $1.50; nonmembers, $2.00.

Results of studies of the engineering problems that must be confronted when feasibility controlled thermonuclear reactors is demonstrated. The studies have disclosed that a large set of boundary conditions must be satisfied, and meeting these with a well balanced integrated design presents an exceptionally challenging set of problems. These include 30,000 to 70,000 G superconducting magnet coils 10 m in diameter, two-phase heat transfer and fluid flow of liquid helium, 4 K helium refrigeration systems, MHD effects on pumping power and heat transfer for large ducts carrying lithium at 1000 C in a niobium-zirconium alloy blanket structure, sputtering and radiation damage to the wall confining the plasma, and potassium-steam binary vapor cycle power conversion systems with a peak temperature of about 1000 C and a thermal efficiency approaching 60%. (Author)

A73-17641 # **Fuel cells for improved electrical power supply.** C. C. Morrill (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 9th, Washington, D.C., Jan. 8-10, 1973, Paper 73-82.* 7 p. Members, $1.50; nonmembers, $2.00.

Current commercial fuel cell technology and the requirements of utility applications lead to a fuel cell system design which is modular in configuration and is composed of three major subsystems. The subsystems include a fuel processor, a fuel cell power section, and an inverter. Fuel cell operational characteristics are discussed, giving attention to its high efficiency, its environmental characteristics, the load response, and the operational modes. G.R.

A73-17667 * # **Review of controlled fusion research using laser heating.** A. Hertzberg (Washington, University, Seattle, Wash.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 11th, Washington, D.C., Jan. 10-12, 1973, Paper 73-258.* 44 p. 63 refs. Members, $1.50; nonmembers, $2.00. NSF Grant No. GK-28562; Contract No. AT(45-1)-2225; Grant No. NGR-48-002-044.

Development of methods for generating high laser pulse energy has stimulated research leading to new ideas for practical controlled thermonuclear fusion machines. A review is presented of some important efforts in progress, and two different approaches have been selected as examples for discussion. One involves the concept of very short pulse lasers with power output tailored, in time, to obtain a nearly isentropic compression of a deuterium-tritium pellet to very high densities and temperatures. A second approach utilizing long wavelength, long pulse, efficient gas lasers to heat a column of plasma contained in a solenoidal field is also discussed. The working requirements of the laser and various magnetic field geometries of this approach are described. (Author)

A73-17668 **New energy systems for space flight (Neue Energiesysteme für die Raumfahrt).** W. Peschka (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Energiewandlung und elektrische Antriebe, Stuttgart, West Germany). Munich, Wilhelm Goldmann Verlag (Das Wissenschaftliche Taschenbuch, Abteilung Technik und Technologie. Part 5), 1972. 212 p. 107 refs. In German. $10.75.

Energy requirements for space applications are examined. Chemical energy sources are suitable in cases in which a high power is needed for short time intervals. One of the most important energy sources is provided by solar radiation. The characteristics of nuclear energy are also considered, taking into account radioactive isotopes and processes based on fission or fusion. Devices for the conversion of energy include electrochemical systems of various types, photoelectric systems, thermoelectric systems, thermionic systems, and mechanoelectrical systems. The design of energy systems of various types is discussed, taking into account photovoltaic devices, nuclear space power systems, and magnetogasdynamic systems. G.R.

A73-20107 **Large-scale applications of superconducting coils.** Z. J. J. Stekly and R. J. Thome (Magnetic Corporation of America, Waltham, Mass.). *IEEE, Proceedings,* vol. 61, Jan. 1973, p. 85-95. 52 refs.

After a brief review of the main characteristics of superconductors and superconducting windings in general, specific applications of superconducting coils are discussed. These include high-energy physics, controlled thermonuclear fusion, MHD power generation, inductive energy storage, and levitation of high-speed ground vehicles. Photographs and illustrations are included to describe some of the existing systems as well as some systems which are presently conceptual in nature. (Author)

A73-20396 **Energy conversion dynamics.** H. K. Messerle (Sydney, University, Sydney, Australia). *Energy Conversion,* vol. 13, Jan. 1973, p. 19-23. 10 refs.

An attempt is made to show how irreversible thermodynamics and losses can be accounted for as an extension of energy conversion statics. The N-port representation of a storage element is discussed together with reversible electro-caloric relations, flux rates, power flow and energy function, and state space relations. In conclusion, it is stated that general system equations for directly coupled and connected system elements can be related to the basic stored energy function if loss flux rates in the incremental performance relations are taken into account. G.R.

A73-20467 * # **Isotope Brayton space power systems and their technology.** H. Schwartz (NASA, Lewis Research Center, Cleveland, Ohio). *American Nuclear Society, International Meeting, 1972, Washington, D.C., Nov. 12-17, 1972, Paper.* 20 p. 8 refs.

The objectives of the NASA-Lewis Research Center Brayton Space Power Program and the advantages of achieving an isotope Brayton space power system are enumerated. The paper describes the 2-15 kWe Brayton engine, its subsystems, and major components, and summarizes the status of the test program. Two areas of Brayton constituent technology are discussed - gas bearings and heat exchangers. A summary is given of a 500-2500 W isotope Brayton space power system study that showed very attractive performance, simplicity, and low cost for a system in this power range. (Author)

A73-22203 **Self-contained submergeable energy sources (Sources d'énergie autonomes immergeables).** Y. Touré (Ministère des Armées, Services Techniques, Paris, France). *(Association Technique Maritime et Aéronautique, Session, 72nd, Paris, France, May 15-19, 1972.) Association Technique Maritime et Aéronautique, Bulletin,* no. 72, 1972, p. 119-138; Discussion, p. 139. 6 refs. In French.

Thermoelectric radioisotope generators and nuclear thermoelectronic reactors are discussed. The former have a low electric power density (about one watt/sq cm), and the latter have a high power density (about 10 watt/sq cm). The principles upon which they are based, and the actual state of their specific characteristics are described. Since each functions by direct conversion of heat to electricity, their operation is anaerobic, self-contained, and reliable, and hence are particularly suited for service under water. The French program in this field is reviewed. F.R.L.

A73-22751 **Intersociety Energy Conversion Engineering Conference, 7th, San Diego, Calif., September 25-29, 1972, Proceedings.** Conference sponsored by ACS, AIAA, ASME, IEEE, AIChE, ANS, and SAE. Washington, D.C., American Chemical Society, 1972. 1543 p. Members, $50; nonmembers, $60.

Topics discussed include fuel-cell and battery technology; silicon-germanium thermoelectric technology; life performance of thermoelectric materials and generators; thermoelectric power generation and cooling; advanced prime movers; manned space power systems; advanced unmanned spacecraft power systems; isotope

systems; reactor subsystems, power conditioning and computer simulation; solar power technology; biomedical energy systems; thermionic technology; military ground power; various advanced power generation, propulsion, and energy transfer systems; nuclear energy systems; and hydrogen energy systems.

Individual items are announced in this issue. A.B.K.

A73-22752 **Autonomous hydrogen/air fuel cell for long-life missions.** Y. Breelle, J. Cheron, A. Grehier (Institut Français du Pétrole, des Carburants et Lubrifiants, Rueil-Malmaison, Hauts-de-Seine, France), and R. Vic (Compagnie Industrielle des Piles Electriques, France). In: Intersociety Energy Conversion Engineering Conference, 7th, San Diego, Calif., September 25-29, 1972, Proceedings. Washington, D.C., American Chemical Society, 1972, p. 1-6.

Design and construction of an autonomous H2/air fuel cell for the purpose of power feeding a 70-W radio-beacon for 5000 hr. The reliability required for this use led to the development of a cell operating at low specific power and with no rotating parts. The results obtained during climatic tests (minus 30 to plus 50 C) and endurance tests (seven months) show that the reliability of this generator is similar to that of standard ce .. (Author)

A73-22766 * **Hybrid TE panel test results.** W. J. Bitano (NASA, Lewis Research Center, Cleveland, Ohio). In: Intersociety Energy Conversion Engineering Conference, 7th, San Diego, Calif., September 25-29, 1972, Proceedings. Washington, D.C., American Chemical Society, 1972, p. 194-199.

Test results are presented for a nine couple (3 x 3 array) thermoelectric panel of hybrid thermocouples. In the hybrid couple, a hollow cylinder of p-type Si-Ge is used to encapsulate a segmented PbTe/Si-Ge n-leg. The hybrid couple is predicted to offer a 10 to 15% improvement in performance relative to all Si-Ge couples. The efficiency, output power, and internal resistance of the panel, as well as the resistances of the individual hybrid couples, are presented as a function of test time covering a period of more than 2600 hours. Initial test results indicated hybrid couple performance consistent with design predictions. However, the 10 to 15% improvement over all-Si-Ge couples demonstrated initially by the hybrid couple was offset by the high resistance that developed following a thermal cycle due to heater failure after 600 hours of testing. (Author)

A73-22793 * **Isotope Brayton electric power system for the 500 to 2500 watt range.** R. P. Macosko, G. J. Barna, H. B. Block, and B. D. Ingle (NASA, Lewis Research Center, Cleveland, Ohio). In: Intersociety Energy Conversion Engineering Conference, 7th, San Diego, Calif., September 25-29, 1972, Proceedings. Washington, D.C., American Chemical Society, 1972, p. 522-527. 6 refs.

An extensive study was conducted at the Lewis Research Center to evaluate an isotope Brayton electric power system for use in the 500 to 2500 W power range. The study emphasized overall system simplicity in order to reduce parasitic power losses and improve system reliability. The study included detailed parametric cycle analysis, conceptual component designs, and evaluation of system packaging. The study has resulted in the selection of a single-loop system (gas) with six major components including one rotating unit. Calculated net system efficiency varies from 23 to 28% over the power range. The use of the Pu-238 heat source being developed for the Multi-Hundred-Watt Radioisotope Thermoelectric Generator program was assumed. (Author)

A73-22799 **Nuclear power system study.** J. H. Van Osdol, R. F. Wilson (North American Rockwell Corp., Atomics International Div., Canoga Park, Calif.), J. E. Hengle (USAF, Space and Missile Systems Organization, El Segundo, Calif.), and D. E. Reardon (AEC, San Francisco, Calif.). In: Intersociety Energy Conversion Engineering Conference, 7th, San Diego, Calif., September 25-29, 1972, Proceedings. Washington, D.C., American Chemical Society, 1972, p. 559-567. Contract No. AT(04-3)-701.

A study was performed to determine the preferred nuclear power source for spacecraft using either of four types of cryogenic cooler cycles, i.e., the rotary reciprocator, Vuilleumier, turbo-brayton, or Stirling. These spacecraft require electrical power in the 1 to 4 kW range, long satellite life (3-5 years), and relatively low earth orbits. The nuclear power systems investigated included both radioisotope and reactor heat sources. For the radioisotope systems, RTG's and heat sources with Brayton or organic-Rankine power conversion systems were considered, with either plutonium or curium as the fuel. Reactor systems were limited to the zirconium-hydride reactor, with either thermoelectric, Brayton, or organic-Rankine power conversion systems. For the Vuilleumier cooler, where both electrical and thermal power were required, a radio-isotope heat source was considered in conjunction with a solar array. Spacecraft designs and integration concepts were developed for each type of power system over the range of mission and system parameters specified. (Author)

A73-22815 * **Thermionic reactor program - An overview.** D. S. Beard and J. J. Lynch (AEC-NASA, Space Nuclear Systems Office, Washington, D.C.). In: Intersociety Energy Conversion Engineering Conference, 7th, San Diego, Calif., September 25-29, 1972, Proceedings. Washington, D.C., American Chemical Society, 1972, p. 1036-1040.

An overview of the AEC/NASA thermionic reactor program is presented with emphasis on the latest progress in this technology. The possible applications for utilization of thermionic reactors are reviewed and the joint AEC/NASA program approach to demonstrate thermionic technology is outlined. The thermionic reactor technology programs of France, West Germany, and the Soviet Union are highlighted. (Author)

A73-22821 **The phosphoric acid fuel cell, a long life power source for the low to medium wattage range.** O. J. Adhart (Engelhard Minerals and Chemicals Corp., East Newark, N.J.). In: Intersociety Energy Conversion Engineering Conference, 7th, San Diego, Calif., September 25-29, 1972, Proceedings. Washington, D.C., American Chemical Society, 1972, p. 1097-1102. 6 refs.

A73-22823 * **Hall current effects in the Lewis magneto-hydrodynamic generator.** L. D. Nichols and R. J. Sovie (NASA, Lewis Research Center, Cleveland, Ohio). In: Intersociety Energy Conversion Engineering Conference, 7th, San Diego, Calif., September 25-29, 1972, Proceedings. Washington, D.C., American Chemical Society, 1972, p. 1125-1130. 8 refs.

Data obtained in the Lewis MHD generator are compared with theoretical values calculated using the Dzung (1966) theory. The generator is operated with cesium seeded argon as the working fluid. The gas temperature varies from 1800 to 2100 K, the gas pressure from 19 to 22 N/sq cm, the Mach number from .3 to .5, and the magnetic field strength from .2 to 1.6 tesla. The analysis indicates that there is incomplete seed vaporization and that Hall current shorting paths (through the working fluid to ground at both the entrance and exit of the channel) are limiting generator performance. (Author)

A73-22829 * **Exploratory investigation of an electric power plant utilizing a gaseous core reactor with MHD conversion.** J. R. Williams, Y. Y. Yung, K. D. Kirby, and J. D. Clement (Georgia Institute of Technology, Atlanta, Ga.). In: Intersociety Energy Conversion Engineering Conference, 7th, San Diego, Calif.,

September 25-29, 1972, Proceedings. Washington, D.C., American Chemical Society, 1972, p. 1305-1311. 19 refs. Grant No. NGR-11-002-145.

A73-23278 **Prospects for radiovoltaic energy conversion (Perspectives en conversion d'énergie radiovoltaique).** R. Bomal, A. Manin, and K. Steinschaden (Commissariat à l'Energie Atomique, Centre d'Etudes Nucléaires de Saclay, Gif-sur-Yvette, Essonne, France). In: Power from radioisotopes; International Symposium, 2nd, Madrid, Spain, May 29-June 1, 1972, Proceedings. Paris, Organisation de Coopération et de Développement Economiques, 1972, p. 223-240. 16 refs. In French.

There is a large field of utilization for conversion of radioisotopic energy by the radiovoltaic effect. The ionizing particles emitted by a radioisotopic source penetrate into a semiconductor and create 'electron-hole' pairs. A voltage appears at the boundary of the junction, and a current establishes itself. Tritium appears to be the most suitable element for commercialization of the process. Titanium-tritium sources and a semiconductor converter are described, and experimental results are given. The procedure for deposition of the titanium-tritium source on the semiconductor is outlined. Tritium microgenerators should find applications in timekeeping and in medicine. F.R.L.

A73-23279 **A model of a thermophotovoltaic radionuclide battery.** H. Rabenhorst and G. R. Tschulena (Battelle-Institut, Frankfurt am Main, West Germany). In: Power from radioisotopes; International Symposium, 2nd, Madrid, Spain, May 29-June 1, 1972, Proceedings. Paris, Organisation de Coopération et de Développement Economiques, 1972, p. 241-252. Research supported by the Ministerium für Bildung und Wissenschaft.

The paper deals with a model of a thermophotovoltaic energy converter. Since the effective spectral range of a photoelectric element is generally small compared with the relatively large spectral range of the thermal radiation, the efficiency of such a system may be expected to be low. The difficulties can be avoided if a broad-band photocell of a material with a graded energy gap is used and the emission from the radiator is confined with an edge filter to a narrow spectral region. By proper choice of the filter and the photosensitive material, it is possible to ensure that the spectral curves of the radiator and the photocell largely overlap. The efficiencies which theoretically can be attained with such a system are indicated. First experimental results obtained on an (In, Ga)As photocell are reported. (Author)

A73-23280 **Practical limits of radiophotovoltaic conversion systems.** D. Schalch and A. Scharmann (Giessen, Universität, Giessen, West Germany). In: Power from radioisotopes; International Symposium, 2nd, Madrid, Spain, May 29-June 1, 1972, Proceedings Paris, Organisation de Coopération et de Développement Economiques, 1972, p. 253-258.

The aim of our work has been the experimental proof of theoretical considerations on power and efficiency limits of radiophotovoltaic devices. Different parameters determining conversion efficiency have been investigated systematically; conversion efficiency of different phosphors, deterioration of different phosphors, optimal thickness of the nuclide phosphor layer, optimal Pm-147 load on the phosphor, and efficiencies of different photocells are covered. (Author)

A73-23473 # **Theoretical possibility of converting the kinetic energy of an ionized gas flow into electricity (O printsipial'noi vozmozhnosti preobrazovaniia kineticheskoi energii potoka ionizirovannogo gaza v elektrichestvo).** O. S. Vorob'ev, V. B. Eliseev, A. N. Ermilov, V. D. Zakharenko, I. V. Orfanov, and S. V. Riabikov. *Akademiia Nauk SSSR, Izvestiia, Energetika i Transport,* Nov.-Dec. 1972, p. 96-100. In Russian.

A73-24594 # **Optimization of superconducting magnetic MHD-generator systems (Ob optimizatsii sverkhprovodiashchikh magnitnykh sistem MGD-generatorov).** O. Coufal (Ustav Specialni Elektroenergetiky, Brno, Czechoslovakia). *Magnitnaia Gidrodinamika,* Oct.-Dec. 1972, p. 115-118. 5 refs. In Russian.

Nonferrous magnetic systems generating a uniform magnetic field in a channel of rectangular cross section are examined. A system of this type is an elliptic winding formed by two intersecting identical elliptic cylinders with identical opposite currents. Another type is the so-called optimum winding, whose configuration is defined by the boundary of the rectangular useful length of a MHD generator and by two step functions. It is shown that there exists an elliptic winding of minimum cross section that will generate a prescribed uniform field. The cross sections of optimal, elliptical, and circular windings are compared for identical magnetic flux densities and identical MHD channel cross sections. V.P.

A73-25346 **Calculation and comparison of the economics of electrochemical fuel cells (Berechnung und Vergleich der Wirtschaftlichkeit von elektrochemischen Brennstoffzellen).** F. A. Pohl, H. Böhm, and H. Carl. *Wissenschaftliche Berichte AEG-Telefunken,* vol. 45, no. 3, 1972, p. 141-146. 12 refs. In German. Research supported by the Bundesministerium für Bildung und Wissenschaft.

A73-25976 **Energy 70; Proceedings of the Fifth Intersociety Energy Conversion Engineering Conference, Las Vegas, Nev., September 21-25, 1970. Volumes 1 & 2.** Conference sponsored by ACS, AIAA, AIChE, ANS, ASME, IEEE, and SAE. Hinsdale, Ill., American Nuclear Society, 1972. Vol. 1, 871 p.; vol. 2, 432 p. Price of two volumes, $40.

Recent developments in energy engineering are described in papers dealing with fusion technology, Brayton-cycle systems, electrochemical power sources, heat-transfer concepts, isotope heat sources, solar cell technology, Rankine-cycle systems, and thermoelectric and thermionic conversion topics. Relevant areas of application include manned and unmanned space missions, biomedical devices, marine systems, and central and compact utility systems. Environmental aspects of energy management are examined along with some advanced new concepts in power generation, conditioning, and distribution.

T.M.

A73-25982 * # **Review of the NASA Brayton System Technology Program.** H. Rochen (NASA, Office of Advanced Research Technology, Washington, D.C.). In: Energy 70; Proceedings of the Fifth Intersociety Energy Conversion Engineering Conference, Las Vegas, Nev., September 21-25, 1970. Volume 1. Hinsdale, Ill., American Nuclear Society, 1972, p. 4-1 to 4-5.

Summary of the research work accomplished on the Brayton space power system during the 1962-1972 period. It is shown that a great amount of Brayton system technology has been developed over this period. In addition, mission users are now seriously considering this system for use in future space missions. M.V.E.

A73-25983 * # **Evaluation testing of a closed Brayton-cycle electrical-power-conversion system.** T. E. Redding, J. M. McGee, and N. C. Luksa (NASA, Manned Spacecraft Center, Houston, Tex.). In: Energy 70; Proceedings of the Fifth Intersociety Energy Conversion Engineering Conference, Las Vegas, Nev., September 21-25, 1970. Volume 1. Hinsdale, Ill., American Nuclear Society, 1972, p. 4-53 to 4-57.

Description of the design and testing of a recuperated, closed Brayton-cycle, electrical power conversion system designated the Brayton Cycle Demonstrator (BCD). The system uses electrical heaters as a heat source, argon as the cycle working fluid, and gas-lubricated foil-type bearings. Objectives of the test program

include (1) evaluation of the overall system performance characteristics and influences on spacecraft integration, (2) familiarization of personnel with operational methods, and (3) determination of system flexibility by operating at a number of off-design conditions. Results obtained to date are discussed. T.M.

A73-25984 * # **A power and load priority control concept as applied to a Brayton cycle turbo-electric generator.** E. L. Kelsey and R. N. Young (NASA, Langley Research Center, Hampton, Va.). In: Energy 70; Proceedings of the Fifth Intersociety Energy Conversion Engineering Conference, Las Vegas, Nev., September 21-25, 1970. Volume 1. Hinsdale, Ill., American Nuclear Society, 1972, p. 4-58 to 4-61.

This paper describes a system to regulate the speed and power output of a Brayton Cycle Power System under varying load. A typical user load profile is applied and a simple load priority and parasitic load is used for system regulation. Power storage is provided by batteries with charge and discharge converters to demonstrate support capability. The breadboard system is tested with the Brayton Cycle Demonstrator at the National Aeronautics and Space Administration, Manned Space Craft Center, Houston, Texas. (Author)

A73-25988 # **Performance studies on a rechargeable hydrogen-oxygen fuel cell.** W. L. Hughes, R. Ramakumar, and H. J. Allison (Oklahoma State University, Stillwater, Okla.). In: Energy 70; Proceedings of the Fifth Intersociety Energy Conversion Engineering Conference, Las Vegas, Nev., September 21-25, 1970. Volume 1. Hinsdale, Ill., American Nuclear Society, 1972, p. 5-105 to 5-110. 5 refs.

Hydrogen-oxygen fuel cells employing a porous membrane made of calcia stabilized zirconia and sintered nickel electrodes with no noble metal catalysts of any kind have the potential for the development of an economical energy storage system. In this paper, the effect of the porosity of the membrane on the polarization curves of electrolysis and fuel cell modes of operation are investigated experimentally and the results are presented and discussed. In addition, the performance results obtained from one such cell under cyclic charge-discharge mode of operation are summarized. (Author)

A73-26024 # **Unmanned reactor-thermoelectric systems for applications in the 1970's.** J. H. Van Osdol and J. M. Howard (North American Rockwell Corp., Atomics International Div., Canoga Park, Calif.). In: Energy 70; Proceedings of the Fifth Intersociety Energy Conversion Engineering Conference, Las Vegas, Nev., September 21-25, 1970. Volume 2. Hinsdale, Ill., American Nuclear Society, 1972, p. 13-44 to 13-48. Contract No. AT(04-3)-701.

The purpose of the paper is to describe the results of a preliminary study of reactor-thermoelectric power systems designed for unmanned space applications. These system designs utilize improved thermoelectric converters and a new low-power reactor design. Modifications to the compact lead telluride tubular module have been identified which result in substantial improvements in efficiency. These modifications have been incorporated in the reference module design, and development is under way. The low-power reactor has a design point of 100 kWt at 1200 F for three years. The design incorporates the latest features under development by Atomics International for the Atomic Energy Commission. In addition to typical system performance characteristics, some of the mission-dependent features of reactor-TE systems are presented, including dormant operation, survivability, and spacecraft thermal power requirements. (Author)

A73-26026 # **100 kWe thermionic power system design.** A. J. Gietzen and W. G. Homeyer (Gulf General Atomic, Inc., San Diego, Calif.). In: Energy 70; Proceedings of the Fifth Intersociety Energy Conversion Engineering Conference, Las Vegas, Nev., September 21-25, 1970. Volume 2. Hinsdale, Ill., American Nuclear Society, 1972, p. 14-19 to 14-26. Contract No. AT(04-3)-167.

An in-core thermionic power system to provide 100 kW net electric power and to meet the shielding requirements of a manned spacecraft is described. The power is produced by thermionic fuel elements similar in design to those now being tested in-pile. Waste heat is removed from the reactor by pumped NaK loops and radiated from heat pipe panels arranged in a cylindrical structure. The electrical output from each pair of fuel elements is processed from about 10 volts dc to about 200 volts dc for transmission to the spacecraft. Factors to be considered in integrating the power system with the Space Base are also discussed. (Author)

A73-26028 # **Development of a plutonium-fueled miniature power supply based on thermionic conversion.** K. A. Gasper (McDonnell Douglas Astronautics Co., Richland, Wash.). In: Energy 70; Proceedings of the Fifth Intersociety Energy Conversion Engineering Conference, Las Vegas, Nev., September 21-25, 1970. Volume 2. Hinsdale, Ill., American Nuclear Society, 1972, p. 14-40 to 14-44. 5 refs.

Recently a miniature nuclear battery based on thermionic conversion and utilizing a plutonium-238 dioxide heat source has been developed. This power supply consists of a relatively low-temperature thermionic diode operating in the vacuum mode and contained within a thermal housing to make the thermal characteristics of the device compatible with the environment of the application. The thermionic diode is coupled electrically with a dc-dc converter to amplify the fractional-volt output of the power cell to the desired voltage level. Over 20 devices of this type have been fabricated with up to 4.8 mW output from a power cell utilizing 1.3 W(t) of fuel inventory, and 2.7 mW output from a power cell utilizing 0.9 W(t) of fuel inventory. (Author)

A73-26034 # **Application of Isotec thermoelectric technology.** G. B. Bradshaw and E. J. Steeger (Gulf General Atomic, Inc., San Diego, Calif.). In: Energy 70; Proceedings of the Fifth Intersociety Energy Conversion Engineering Conference, Las Vegas, Nev., September 21-25, 1970. Volume 2. Hinsdale, Ill., American Nuclear Society, 1972, p. 15-26 to 15-30.

Discussion of recent and current work in thermoelectric technology applications to the development of the TRANSIT radioisotope thermoelectric generator. Development testing under the TRANSIT program is shown to have: (1) verified the adaptability of Isotec panels to new configurations, (2) demonstrated electrical performance characteristics consistent with predictions, and (3) evaluated the structural integrity and thermal efficiency of the design. M.V.E.

A73-27321 # **Qualitative analysis of MHD energy conversion efficiency (Kachestvennyi analiz effektivnosti MGD-preobrazovaniia energii).** V. Iu. Baranov, D. D. Maliuta, V. P. Panchenko, and F. R. Ulinich (Akademiia Nauk SSSR, Institut Atomnoi Energii, Moscow, USSR). *Teplofizika Vysokikh Temperatur,* vol. 11, Jan.-Feb. 1973, p. 167-173. In Russian.

A method is proposed for solving the system of one-dimensional differential equations describing the gas flow in the channel of a Faraday-type MHD generator with ideally segmented electrodes. The convergence efficiency of the generator is determined as a function of the generator length and the load factor. The influence of the channel shape and the inlet Mach number on the conversion factor is examined, and the range of optimal parameters is determined. The energy conversion efficiency of a Faraday-type generator with solid electrodes is discussed. V.P.

A73-28071 **Nonequilibrium ionization in magnetohydrodynamic conversion generators (Sur l'ionisation hors d'équilibre dans les générateurs de conversion magnétohydrodynamique).** J.-P.

Caressa (Aix-Marseille, Université, Marseille, France). *Académie des Sciences (Paris), Comptes Rendus, Série A - Sciences Mathématiques,* vol. 276, no. 12, Mar. 19, 1973, p. 883-886. 6 refs. In French.

Consideration of possible causes for the low Hall electrostatic field value observed in experimental MHD converters. The possibility is shown to explain this low field value by nonequilibrium ionization, without having to resort to the generally invoked ionization instability mechanisms. M.V.E.

A73-29581 **Power Sources Symposium, 25th, Atlantic City, N.J., May 23-25, 1972, Proceedings.** Symposium sponsored by the U.S. Army. Red Bank, N.J., PSC Publications Committee, 1972. 204 p. $20.

Development efforts, design features, materials properties, and performance evaluations are described for primary and secondary battery systems, thermal energy conversion devices, solar cell arrays, and fuel cells. Topics considered include battery degradation mechanisms, charging and charge-maintenance systems, electric power control and conditioning circuits, isotopic power systems, fossil-fuel heated thermionic diodes, an organic Rankine cycle power system, solar cell efficiency improvements, and advanced spacecraft fuel cell systems.

Individual items are announced in this issue. T.M.

A73-29598 **Optimizing power efficiency of hydrazine-oxygen fuel cells.** H. B. Urbach, D. E. Icenhower, and R. J. Bowen (U.S. Naval Ship Research and Development Center, Annapolis, Md.). In: Power Sources Symposium, 25th, Atlantic City, N.J., May 23-25, 1972, Proceedings. Red Bank, N.J., PSC Publications Committee, 1972, p. 182-185. 15 refs. Navy-supported research.

Tests to determine the optimum operation conditions of hydrazine-oxygen cells indicate that their coulombic efficiency is a direct function of current density and an inverse function of hydrazine concentration and temperature. The voltage efficiency, in contrast, is a direct function of temperature and an inverse function of operating time and current density. Power efficiencies above 40% were observed in single cells at 60 C. V.Z.

A73-30950 # **Utilization of thermosiphons in the construction of thermoelectric devices (Ispol'zovanie termosifonov v termoelektricheskom priborostroenii).** E. A. Kolenko and M. G. Verdiev (Akademiia Nauk SSSR, Institut Poluprovodnikov, Leningrad, USSR). *Geliotekhnika,* no. 1, 1973, p. 10-12. In Russian.

The principles of operation of cooling systems employing an evaporation-condensation-evaporation cycle are examined. The effectiveness of such heat exchangers is analyzed, and the advantages which accrue from the use of such systems in thermoelectric devices are pointed out. V.P.

A73-31250 **Ceramics in automotive gas turbines.** A. F. McLean (Ford Motor Co., Dearborn, Mich.). *(American Ceramic Society, Annual Meeting, 7th, Washington, D.C., May 9, 1972.) American Ceramic Society Bulletin,* vol. 52, May 1973, p. 464-466, 482. Research supported by the Ford Motor Co., ARPA, and U. S. Army.

Substantial improvements in specific fuel and air consumption can be obtained by increasing the turbine inlet temperature from 1800 to 2500 F. However, the employment of the presently used nickel-chrome superalloys in small gas turbines where blade cooling is impractical limits the maximum turbine inlet gas temperatures to about 1900 F. The replacement of superalloys with ceramics offers the possibility to overcome this temperature barrier. In a screening program for selecting promising materials silicon nitride and silicon carbide were selected. Current effort is aimed at continuing to develop durability of stationary ceramic components in engine testing and to develop practical methods to fabricate complex shaped turbine rotors from ceramic materials. G.R.

A73-32194 * # **Nuclear air cushion vehicles.** J. L. Anderson (NASA, Lewis Research Center, Cleveland, Ohio). *American Ordnance Association, High-Performance Ships Symposium, Washington, D.C., May 8, 9, 1973, Paper.* 39 p. 42 refs.

This paper serves several functions. It identifies the 'state-of-the-art' of the still-conceptual nuclear air cushion vehicle, particularly the nuclear powerplant. Using mission studies and cost estimates, the report describes some of the advantages of nuclear power for large air cushion vehicles. The paper also summarizes the technology studies on mobile nuclear powerplants and conceptual ACV systems/missions studies that have been performed at NASA Lewis Research Center. (Author)

A73-34111 **Applications of superconductivity.** B. B. Goodman (British Oxygen Co., Ltd., London, England). In: Trends in physics; General Conference, 2nd, Wiesbaden, West Germany, October 3-6, 1972, Lectures. Petit-Lancy, Switzerland, European Physical Society, 1973, p. 67-94. 79 refs.

While, in the past, numerous applications of superconductivity have been suggested, those which now appear capable of competing effectively with other technologies are grouped into just three main areas. By far the most important at present is in the use of Type 2 superconductors to produce large dc (or slowly time dependent) magnetic fields for use in research, in novel types of electrical machinery and possibly in magnetically levitated trains. In this area, the advantage of using superconductors appears to be greatest for large scale projects. Secondly, superconductivity is of interest in two types of application which do not specifically require high fields, linear accelerators and power cables. Finally, the Josephson effect is leading to the development of a rich harvest of electronic devices with unique properties of sensitivity and accuracy. (Author)

A73-34447 **Small engines - Big business /1972 Halford Memorial Lecture/.** J. E. B. Perkins (Rolls-Royce, Ltd., Small Engine Div., Derby, England). *(Royal Aeronautical Society and British Helicopter Advisory Board, Symposium on Heliports, London, England, Mar. 8, 1972.) Aeronautical Journal,* vol. 77, May 1973, p. 240-248.

Small gas turbines, defined as those in the power range up to around 3000 shp and 4000 lb thrust, i.e., engines for general aviation, corporate, and executive aircraft, and limited trainer operations and helicopters are discussed. The background of the small engine business in market and technical terms is developed to highlight a number of features of the small engine business as it exists today. The technical progress made to date is reviewed, examining aspects of fuel consumption, power, weight, and price. Some future market trends for small engines, and the likely solutions in terms of supporting technology are discussed, and the ways in which the industry's structure might develop to support profitably this part of the business are examined. F.R.L.

A73-34694 **Refanned commercial gas turbine engines.** G. M. McRae (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). *Society of Automotive Engineers, Air Transportation Meeting, Miami, Fla., Apr. 24-26, 1973, Paper 730346.* 8 p. Members, $1.25; nonmembers, $2.00.

A NASA sponsored program to develop noise-reduction modifications for the JT3D and JT8D engines was initiated in August 1972. New higher flow single-stage fans are attractive and result in higher bypass ratios with improved thrust and fuel consumption and reduced jet velocities. Fly-over noise reductions as great as 20 EPNdB are shown for the modified engines with nacelle treatment. Engine certification can be completed and production hardware for fleet retrofit or new aircraft can be provided by late 1975. (Author)

A73-35379 **Lasers for fusion.** D. H. Gill (California, University, Los Alamos, N. Mex.). In: Annual Southwestern Conference and Exhibition, 25th, Houston, Tex., April 4-6, 1973, Record. (A73-35357 17-07) New York, Institute of Electrical and Electronics

Engineers, Inc., 1973, p. 430-437. 30 refs. AEC-sponsored research.
A brief review of the theory of absorption of laser light by plasmas and of the necessary requirements for the production of controlled thermonuclear fusion is given. The implications of this theory in regard to the requirements on the laser to be used for fusion are discussed. The three types of lasers being considered for use (electrically pumped gas lasers, chemical, and solid state lasers) are each described with discussion of their relative advantages and disadvantages. The Nd:glass system is described in greater detail since that system is now being used to study the basic light-matter interactions at a number of laboratories around the world. Finally, mention is made of the present status of, and future plans for, large laser systems now being built at some of those laboratories. (Author)

A73-36681 **Improved technology for multiwatt radioisotope heater units.** A. W. Barsell, R. B. Goranson, and P. R. Clements (Donald W. Douglas Laboratories, Richland, Wash.). *Nuclear Technology*, vol. 19, Aug. 1973, p. 117-125. 9 refs. Contract No. AT(45-1)-2166.
The approach considered optimizes radioisotope heater units for long-life protection against credible accident environments, while serving the largest practical number of missions at minimum weight and maximum safety. Safety and lower long-range qualification costs are increased through the use of an optimized design for multiple applications. Design and safety criteria are discussed together with questions of materials development, design parametrics, concept comparisons, and development tests. G.R.

A73-38310 **Engineering aspects of magnetohydrodynamics; Proceedings of the Thirteenth Symposium, Stanford University, Stanford, Calif., March 26-28, 1973.** Symposium sponsored by Stanford University. Edited by M. Mitchner. University, Miss., University of Mississippi, 1973. 366 p. $15.
Calculation and measurement of MHD generator boundary-layer velocity profiles, stability of a nonequilibrium helium-cesium MHD plasma in a regime of fully ionized seed, and thrust stand performance measurements of a lithium fueled applied field MPD arcjet are among the topics covered in papers concerned with plasma flows and instabilities. Other areas covered include liquid-metal generators, system and design studies, and pollution and combustion plasma properties.
M.V.E.

A73-38311 * # **NaK-nitrogen liquid metal MHD converter tests at 30 kW.** D. J. Cerini (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Engineering aspects of magnetohydrodynamics; Proceedings of the Thirteenth Symposium, Stanford, Calif., March 26-28, 1973. University, Miss., University of Mississippi, 1973, p. III.2.1-III.2.7. 10 refs. Contract No. NAS7-100.
Description of the tests performed and test results obtained in an experiment where a NaK-nitrogen liquid metal MHD converter was operated over a range of nozzle inlet pressures of 100 to 165 N per sq cm, NaK flow rates of 46 to 72 kg/sec, and nitrogen flow rates of 3.4 to 3.8 kg/sec. The test results indicate: (1) smooth and stable operation, (2) absence of unexpected electrical or flow losses, and (3) possibility of operation with the expected full power output of 30 kW. M.V.E.

A73-38386 **Intersociety Energy Conversion Engineering Conference, 8th, University of Pennsylvania, Philadelphia, Pa., August 13-16, 1973, Proceedings and Addendum.** Conference sponsored by AIAA, AIChE, ANS, ASME, IEEE, SAE, and ACS. New York, American Institute of Aeronautics and Astronautics, Inc., 1973. Proceedings, 854 p.; Addendum, 180 p. Members, $50.; nonmembers, $60.
The development of energy conversion systems is depicted in papers dealing with the operation, design, performance, materials, testing, and reliability of specific new and improved system concepts. Major topics covered include radioisotope thermoelectric generators, electrochemical power systems, solar power, biomedical power sources, nuclear energy, hydrogen fuel developments, Stirling cycle engines, aerospace power systems, and urban energy sources. Devices examined cover the wet Brayton cycle engine, Rankine cycle engines, the Wankel rotary engine, fuel cells, batteries, gas turbines, nuclear reactors, and utility systems for urban needs.
T.M.

A73-38389 # **Cost-effective radioisotope thermoelectric generator designs involving Cm-244 and Pu-238 heat sources.** P. E. Eggers and J. L. Ridihalgh (Battelle Columbus Laboratories, Columbus, Ohio). In: Intersociety Energy Conversion Engineering Conference, 8th, Philadelphia, Pa., August 13-16, 1973, Proceedings. New York, American Institute of Aeronautics and Astronautics, Inc., 1973, p. 13-20. 12 refs.

A73-38398 # **High power density hydrazine fuel cells.** D. E. Icenhower and H. B. Urbach (U.S. Naval Material Command, Ship Research and Development Center, Annapolis, Md.). In: Intersociety Energy Conversion Engineering Conference, 8th, Philadelphia, Pa., August 13-16, 1973, Proceedings. New York, American Institute of Aeronautics and Astronautics, Inc., 1973, p. 67-71. 7 refs.
A hydrazine-oxygen fuel cell was operated under moderate conditions of temperature and concentration at power densities up to 600 watts per square foot (1000 amperes per square foot at 0.6 volt). At this output, a power efficiency of 32% was obtained at 70 C at less than molar hydrazine concentration. Power efficiencies exceeding 48% were obtained over a power density range from 40 to 200 watts per square foot by optimal matching of the temperature (5 to 80 C) and hydrazine concentration (0.1 to 1.0 molar) to the electrical load. The three major components of cell polarization were examined. Critical resistance losses were minimized by use of a .010-inch asbestos matrix which was more than adequate to prevent leakage of oxygen to the anode at moderate differential pressures.
(Author)

A73-38403 # **High energy density silver-hydrogen cells for space and terrestrial applications.** R. J. Haas and D. C. Briggs (Philco-Ford Corp., Palo Alto, Calif.). In: Intersociety Energy Conversion Engineering Conference, 8th, Philadelphia, Pa., August 13-16, 1973, Proceedings. New York, American Institute of Aeronautics and Astronautics, Inc., 1973, p. 116-120.
Description of the performance and design characteristics of recently developed silver-hydrogen cells. The first phase of this program encompassed design and electrical cycling of single and multiple plate cells. Based on the high rate (2C) long cycle life performance demonstrated by these cells, a series of production type 4.0 and 20.0 ampere-hour cells were designed, constructed, and electrically characterized. The basic cell design consists of rectangular silver and catalized fuel cell plates alternately stacked in a hermetically sealed prismatic container. Electrical connection is provided by ceramic-metal seals. Heat is dissipated from the cell core through the flat container surfaces to intercostal thermal shunts, minimizing temperature gradients within the cell. In general, the performance indicates that this design is capable of producing energy densities in excess of 60 watt hours per pound. (Author)

A73-38410 # **Thermoelectric nuclear batteries.** L. C. Olsen and A. Bennett (Donald W. Douglas Laboratories, Richland, Wash.). In: Intersociety Energy Conversion Engineering Conference, 8th, Philadelphia, Pa., August 13-16, 1973, Proceedings. New York, American Institute of Aeronautics and Astronautics, Inc., 1973, p. 461-467. Research supported by the McDonnell Douglas Astronautics Independent Research and Development Program.

An approach to building thermoelectric nuclear batteries in the milliwatt power range combines bismuth-telluride thermopiles with plutonia fuel capsules. Power produced by the battery is coupled to a dc-dc converter to increase the output voltage. The program involved development of bismuth-telluride thermopiles, as well as processing techniques for vacuum-packaged batteries and dc-dc converters. Thermopiles utilizing indium-bismuth solder which melts at 117 C were developed. First prototypes used Xe as the insulator between the outer can and the fuel capsule; one such battery fueled with 1.3 W (thermal) of Pu-238 produced 8 mWe of conditioned power, for 0.6% system efficiency. Current Model NT-50 batteries fueled with 1.5 W (thermal) of Pu-238 produce 22 mW of conditioned power, for 1.5% system efficiency; these batteries use improved bismuth-telluride thermopiles and vacuum package. (Author)

A73-38411 * # **Exploratory study of several advanced nuclear-MHD power plant systems.** J. R. Williams, J. D. Clement (Georgia Institute of Technology, Atlanta, Ga.), R. J. Rosa (Georgia Institute of Technology, Atlanta, Ga.; Avco Everett Research Laboratory, Everett, Mass.), and Y. Y. Yang. In: Intersociety Energy Conversion Engineering Conference, 8th, Philadelphia, Pa., August 13-16, 1973, Proceedings. New York, American Institute of Aeronautics and Astronautics, Inc., 1973, p. 558-565. 21 refs. Grant No. NGR-11-002-145.

In order for efficient multimegawatt closed cycle nuclear-MHD systems to become practical, long-life gas cooled reactors with exit temperatures of about 2500 K or higher must be developed. Four types of nuclear reactors which have the potential of achieving this goal are the NERVA-type solid core reactor, the colloid core (rotating fluidized bed) reactor, the 'light bulb' gas core reactor, and the 'coaxial flow' gas core reactor. Research programs aimed at developing these reactors have progressed rapidly in recent years so that prototype power reactors could be operating by 1980. Three types of power plant systems which use these reactors have been analyzed to determine the operating characteristics, critical parameters and performance of these power plants. Overall thermal efficiencies as high as 80% are projected, using an MHD turbine-compressor cycle with steam bottoming, and slightly lower efficiencies are projected for an MHD motor-compressor cycle. (Author)

A73-38412 * # **The Satellite Nuclear Power Station - An option for future power generation.** J. R. Williams and J. D. Clement (Georgia Institute of Technology, Atlanta, Ga.). In: Intersociety Energy Conversion Engineering Conference, 8th, Philadelphia, Pa., August 13-16, 1973, Proceedings. New York, American Institute of Aeronautics and Astronautics, Inc., 1973, p. 566-573. 22 refs. Grant No. NGR-11-002-145.

A new concept in nuclear power generation is being explored which essentially eliminates major objections to nuclear power. The Satellite Nuclear Power Station, remotely operated in synchronous orbit, would transmit power safely to the ground by a microwave beam. Fuel reprocessing would take place in space and no radioactive materials would ever be returned to earth. Even the worst possible accident to such a plant should have negligible effect on the earth. An exploratory study of a satellite nuclear power station to provide 10,000 MWe to the earth has shown that the system could weigh about 20 million pounds and cost less than $1000/KWe. An advanced breeder reactor operating with an MHD power cycle could achieve an efficiency of about 50% with a 1100 K radiator temperature. If a hydrogen moderated gas core reactor is used, its breeding ratio of 1.10 would result in a fuel doubling time of a few years. A rotating fluidized bed or NERVA type reactor might also be used. The efficiency of power transmission from synchronous orbit would range from 70% to 80%. (Author)

A73-38414 # **Isotope organic Rankine cycle electric power systems for the 150 to 1500 watt range.** J. E. Boretz (TRW Systems Group, Redondo Beach, Calif.). In: Intersociety Energy Conversion Engineering Conference, 8th, Philadelphia, Pa., August 13-16, 1973, Proceedings. New York, American Institute of Aeronautics and Astronautics, Inc., 1973, p. 601-608.

An in-house study was conducted to evaluate isotope organic Rankine cycle electric power systems in the 150 to 1500-W power range. Both conventional (turbogenerator only) and 'hybrid' (cascaded thermoelectrics used in a 'topping' manner) were considered. The working fluids, thermoelectric elements, and cycle conditions considered are reviewed. In addition, the performance characteristics for both the 'turbogenerator only' and 'hybrid' systems are summarized. The static conversion system is designed to operate in a 'topping' or 'binary' mode with respect to the dynamic energy conversion system. Thus after generating a portion of the total system electric power output in the thermoelectric elements, the heat rejected from this system provides the heat input to the boiler of the organic Rankine cycle energy conversion system. The electric power output from the thermoelectric stage is then combined with the output power from the turbogenerator unit. (Author)

A73-38418 # **The multi-hundred watt RTG - Technology background and flight systems program.** A. J. Arker and R. E. Schafer (General Electric Co., Philadelphia, Pa.). In: Intersociety Energy Conversion Engineering Conference, 8th, Philadelphia, Pa., August 13-16, 1973, Proceedings. Addendum. New York, American Institute of Aeronautics and Astronautics, Inc., 1973, p. 1-14.

A summary system description and program schedule and status are presented for the development of the multihundred watt radioisotope thermoelectric generator (MHW-RTG). Also described are the major technology developments undertaken in support of the thermoelectric converters and isotope heat sources which form the RTG. The MHW-RTG modules generate 150 W(e), each utilizing a 2400 W(t) Pu-238 heat source and SiGe thermocouples. The prime structure is a beryllium case, and the thermal insulation is alternate layers of molybdenum foil and quartz cloth. Other hardware in the system includes loading and assembly stations, shipping and storage containers, electric heat sources, test consoles, and other ancillary equipment. (Author)

A73-38419 # **MHW converter design and performance summary.** C. H. Bixler, V. F. Haley, and C. E. Kelly (General Electric Co., Philadelphia, Pa.). In: Intersociety Energy Conversion Engineering Conference, 8th, Philadelphia, Pa., August 13-16, 1973, Proceedings. Addendum. New York, American Institute of Aeronautics and Astronautics, Inc., 1973, p. 15-21. Contract No. AT(29-2)-2831.

Description of the multihundred watt (MHW) converter design, including a summary of the operating characteristics for on-pad and orbital conditions and an illustration of the radioisotope thermoelectric generator (RTG) configurations for the LES 8/9 and Mariner J and S applications. The generator uses a 2400-W Pu-238 heat source and has been configured to deliver 150 W of power at 30 V at the beginning of mission with a requirement to produce 125 W after five years of orbital operation. The converter consists of 312 silicon-germanium thermoelectrics and a multilayer molybdenum foil astroquartz insulation system housed within a sealed beryllium outer shell which serves as the RTG primary structure and external waste heat radiator. An inert cover gas is provided to protect the foil insulation during ground operations and is vented to space after launch. (Author)

A73-38422 # **Performance models for the MHW converter.** C. E. Kelly, J. A. Loffreda (General Electric Co., Philadelphia, Pa.), and R. Lorentzen (RCA, Harrison, N.J.). In: Intersociety Energy Conversion Engineering Conference, 8th, Philadelphia, Pa., August 13-16, 1973, Proceedings. Addendum. New York, American Institute of Aeronautics and Astronautics, Inc., 1973, p. 37-46.

The multihundred watt (MHW) converter is a 150-W(e) 30-V power supply designed for a space application. The energy source is 2400 watts of Pu-238. Three hundred and twelve silicon-germanium thermoelectric couples convert the heat energy at an initial system efficiency of 6.5%. A molybdenum/astroquartz multifoil insulation system is used to minimize heat losses. A series of tests are in progress to assist in the understanding of the temperature and time dependence of the material property changes. A computer model of the MHW converter is being developed to assist in the projection of long-term performance. Results of tests and modeling to date are discussed and the expected band of performance at five years is shown as a function of various extrapolation models and as a function of the beginning of mission hot junction temperature. (Author)

A73-39618 # **Experimental investigation of the characteristics of a nonequilibrium MHD generator (Eksperimental'noe issledovanie kharakteristik neravnovesnogo MGD-generatora).** A. E. Buznikov, V. E. Vanin, and V. V. Kirillov (Akademiia Nauk SSSR, Nauchno-Issledovatel'skii Institut Vysokikh Temperatur, Moscow, USSR). *Teplofizika Vysokikh Temperatur,* vol. 11, May-June 1973, p. 622-631. 23 refs. In Russian.

Results of experimental studies of a nonequilibrium MHD generator operating with a potassium-seeded argon plasma. Test measurements were performed at Hall numbers ranging from 1.5 to 25, electron temperatures of 1800 to 2800 K, electron-to-neutral particle temperature ratios of 1.1 to 1.8, and various values of relative wall temperature. It is shown that in addition to the influence of ionizational instability, the characteristics of a nonequilibrium MHD generator are substantially affected by imperfections of electrical insulation in the channel and by inhomogeneities of nonequilibrium-plasma conductivity in layers near the electrodes. T.M.

A73-39619 # **Experimental investigation of the performance of a porous electrode in an MHD converter during the injection of argon with potassium addition (Eksperimental'noe issledovanie raboty poristogo elektroda MGD-preobrazovatelia pri vduve argona s prisadkoi kaliia).** V. O. German, Iu. P. Kukota, G. A. Liubimov, B. V. Parfenov, I. S. Poltavtseva, V. M. Sleptsov, and G. M. Shchegolev (Akademiia Nauk Ukrainskoi SSR, Institut Tekhnicheskoi Teplofiziki and Institut Problem Materialovedeniia, Kiev, Ukrainian SSR; Moskovskii Gosudarstvennyi Universitet, Moscow, USSR). *Teplofizika Vysokikh Temperatur,* vol. 11, May-June 1973, p. 632-638. 7 refs. In Russian.

A73-41676 **Direct conversion of thermonuclear plasma energy by high magnetic compression and expansion.** T. A. Oliphant, F. L. Ribe (California, University, Los Alamos, N. Mex.), and T. A. Coultas (Argonne National Laboratory, Argonne, Ill.). *Nuclear Fusion,* vol. 13, Aug. 1973, p. 529-532. AEC-sponsored research.

The useful work output from the magnetic compression, decompression, and alpha-particle energy deposition of a single-cycle D-T theta-pinch reactor is considered. The intrinsic thermodynamic efficiency of the direct conversion cycle from alpha-particle energy to work is 62%. The direct-conversion output work is available to the reactor system at essentially 100% efficiency, and has an appreciable effect on the circulating power fraction and plant efficiency. M.V.E.

A73-41876 # **Physical bases of thermionic energy conversion (Fizicheskie osnovy termoemissionnogo preobrazovaniia energii).** I. P. Stakhanov, A. S. Stepanov, V. P. Pashchenko, and Iu. K. Gus'kov. Moscow, Atomizdat, 1973. 375 p. 294 refs. In Russian.

A study is made of the physical processes occurring in a low-temperature weakly ionized plasma. The structure of the electrode layer in the plasma is discussed, as well as the mechanism of ionization of atoms in the discharge and problems concerning the occurrence and stability of vibrations in a weakly ionized plasma. Methods of calculating the current-voltage characteristics of a gas discharge are described, and the calculation of the kinetic coefficients of a low-temperature three-component plasma in a magnetic field is discussed. Particular attention is paid to a study of a low-voltage arc discharge. The effect of various additives to cesium on the operation of a thermionic energy converter is also considered. A.B.K.

A73-42906 **High-efficiency converter and battery charger for an RTG power source.** R. L. Donovan (Martin Marietta Aerospace, Denver, Colo.). In: Power Electronics Specialists Conference, Pasadena, Calif., June 11-13, 1973, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1973, p. 46-57. 6 refs.

Spacecraft power systems utilizing radioisotope thermoelectric generators (RTGs) as primary power sources present an uncommon set of requirements and limitations for interfacing dc-to-dc converters. A converter configuration is presented that complements these RTG characteristics. The circuit is a variation of the basic flyback regulator modified to provide input regulation. The converter has two isolated outputs. One output provides power directly to the spacecraft equipment, while the second is used for battery charging. Design problems addressed are noise generation in long cable lengths between the RTG source and the converter, regulation of the converter input to obtain maximum power transfer from the RTG to the equipment, and provision for two converter outputs while maintaining high efficiency with a simple design implementation. The design of a converter and battery charger used on the Viking Lander Capsule is presented as an illustration. (Author)

N68-10050*# General Electric Co., Philadelphia, Pa. Missile and Space Div.

COMPARISON OF LOAD BEARING AND NON-LOAD BEARING RADIATORS FOR NUCLEAR RANKINE SYSTEMS

R. D. Cockfield 6 May 1967 98 p refs
(Contract NASw-1449)
(NASA-CR-72307; GE-ANSO-6300-203) CFSTI: HC $3.00/MF $0.65 CSCL 18N

A comparison is made between load bearing radiators in a conical configuration, and nonload bearing radiators in a flat panel configuration, for a nuclear potassium Rankine powerplant. For a typical unmanned interplanetary probe mission the load bearing radiator showed a payload advantage of four percent at a power level of 300 kWe, and an advantage of thirty percent at 1200 kWe. The comparison shows that the nonload bearing radiator does not achieve the payload advantage for interplanetary missions that might be anticipated by virtue of its ability to dispose of launch structure. Author

N68-10758# Aeroprojects, Inc., West Chester, Pa.

APPLICATIONS OF ULTRASONIC ENERGY: ULTRASONIC INSTRUMENTATION FOR NUCLEAR APPLICATIONS

Bimonthly Progress Report, Jun. 1–Jul. 31, 1967

Aug. 1967 11 p ref
(Contract AT(30-1)-3622)
(NYO-3622-10; BMPR-35) CFSTI: HC $3.00/MF $0.65

Development of ultrasonic instrumentation for incipient boiling detection in liquid metals or fused salts is outlined. Flow rate experiments using an ultrasonic flowmeter are presented. NSA

N68-10892# Institut für Plasmaphysik G.m.b.H., Garching (West Germany)

THE ELECTRICAL CONDUCTIVITY IN ARGON POTASSIUM AND HELIUM POTASSIUM PLASMAS WITH ELEVATED ELECTRON TEMPERATURES IN CROSSED ELECTRIC AND MAGNETIC FIELDS

G. Brederlow and R. Hodgson Sep. 1967 30 p refs
(IPP-3/59) CFSTI: $3.00

Methods and results of measurements of the tensor conductivity and electron temperatures in argon potassium and helium potassium plasmas with elevated electron temperatures under MHD generator conditions are described. Electrode and wall effects that would make the measurements more difficult to interpret have been eliminated. Calculations predict that the scalar electrical conductivity should drop slightly with increasing magnetic field strength. However, the measured effective scalar conductivity was less than the theoretically predicted value. The discrepancy is apparently due to instabilities. These instabilities were investigated. At current densities and field strength values at which instabilities were observed, the effective Hall coefficient has been found to be nearly independent of the magnetic field strength. The measurements have shown that the efficiency of a noble gas MHD generator is adversely affected not only by the decrease of the scalar conductivity in a magnetic field, but also by the onset of instabilities. Author

N68-10967# Westinghouse Electric Corp., Lima, Ohio. Aerospace Electrical Div.

ELECTRICAL COMPONENT TECHNOLOGY FOR 0.25 TO 10.0 MEGAWATT SPACE POWER SYSTEMS, DESIGN STUDY Quarterly Technical Progress Report, Mar. 1, 1966–May 31, 1967

A. E. King, ed. 31 May 1967 93 p
(Contract AT(04-3)-679)
(SAN-679-3; QTPR-3) CFSTI: HC$3.00/MF$0.65

Parametric studies to determine minimum system weight as a function of electrical component rating, voltage, frequency, and speed are presented on ac generators, ac motors, power conditioning, and power distribution equipment for 0.25 to 10.0 megawatt space nuclear electric power plants utilizing the Rankine conversion cycle. The power conditioning and distribution equipment includes transformers, rectifiers, frequency changers, contactors, and transmission lines. Concluding parametric data are presented for the electrical system components listed. Electrical power systems are presented to illustrate electrical load break-down on probable missions requiring 0.25 to 10.0 megawatts of power. Experiments to verify analytical techniques for inductor generator designs typical of high-power, high-speed, high-frequency, high temperature applications are presented. Author (NSA)

N68-11030* Allis-Chalmers Mfg. Co., Milwaukee, Wis. Research Div.

RESEARCH AND DEVELOPMENT ON FUEL CELL SYSTEMS Quarterly Progress Report, Jan. 1–Mar. 31, 1966

31 Mar. 1967 162 p
(Contract NAS8-2696)
(NASA-CR-90210; QPR-7) CSCL 10A

Details are presented on the work completed during this reporting period. Research and technological activities are discussed for the following areas: anode catalyst density, matrix water transport rate tests, reactant impurities tests, high and room temperature storage, high-loading electrode test, manifold test, KOH flush of expended fuel cell, and theoretical analysis of shell type heat exchange. Tests of the thermal mockup and advanced thermal design system are described, and it is felt that the system demonstrated the ability to remove rejected heat up to an equivalent fuel cell load of 2.5 kW with a coolant inlet temperature of 100°F and a flow rate of 90 lb/hr. Results of the 2.0 kW fuel cell power system test models are discussed. N.E.N.

N68-11139 Deutsche Versuchsanstalt fur Luft- und Raumfahrt, Stuttgart (West Germany). Inst. fuer Energiewandlung und Elektrische Antriebe.

HIGH TEMPERATURE ENERGY SYSTEMS WITH PLASMA REACTORS AND INDUCTIVE MAGNETOPLASMADYNAMIC CONVERTERS [HOCHTEMPERATUR-ENERGIESYSTEME UNTER VERWENDUNG VON PLASMAREAKTOREN UND INDUKTIVEN MAGNETOPLASMADYNAMISCHEN WANDLERN]

W. Peschka Sep. 1967 25 p refs In GERMAN; ENGLISH summary
(DLR-FB-67-59) CFSTI: $3.00

The purpose of this paper is to investigate possible future power generating equipment which operates with high temperature plasma as a working medium and subsequently with high power density. This temperature range requires reactors whose nuclear fuel is in the plasma (fission or fusion reactors) coupled to magnetoplasmadynamic generators acting as energy converters. Electrodeless MPD-Generators with all their advantages can be successfully employed. The technological ramifications arising from the application of these high temperatures with respect to the reactors and the MPD-Generators as well as to the heat release equipment are discussed. Author

N68-11382# Minnesota Mining and Mfg. Co., St. Paul, Minn.

SNAP-21 PROGRAM. PHASE 2: DEEP SEA RADIOISOTOPE-FUELED THERMOELECTRIC GENERATOR POWER SUPPLY SYSTEM Quarterly Report, Apr. 1–Jun. 30, 1967 1967

F. K. Fox Jul. 1967 139 p
(Contract AT(30-1)-3691)
(MMM-3691-20; QR-4) CFSTI: HC$3.00/MF$0.65

Progress is reported on the SNAP-21 system design study. The generator A10D-z was completely assembled and found to have some fiberglass insulation sleeving short circuits which were corrected. Weld closures and insulation system were completed. Radiation effectivenss of the biological shield was determined using a 200 W ^{90}SrO source. 214 couples including both the instrumented types and those with output tap assemblies were fabricated. Development work is continuing to improve the physical strength of the bond of the N- and P-leg couples during bonding through improved fabrication techniques. Test plans for compatibility testing of multi-layer insulation were completed, the test fixture was designed, and 500 of the 2000 hrs of testing were accomplished. Tests concerning the relationship between degradation in the resistance of the bias section of the thermopile and the starting characteristics of the power conditioner showed that the power conditioner operating at the rated load with a degradation of 2:1 in the thermopile bias section will not inhibit starting under normal operating load. Test sections for the electrically heated fuel capsules, laboratory corrosion specimens and the galvanic and marine fouling system components were fabricated. The results of ultrasonic tests on the first weld development closures on fuel capsules were evaluated. Some cold end heat transfer tests were completed. Conceptual drawings of the 20 W system were started. An updated design envelope for the 20 W high vacuum thermal insulation system was prepared. The thermoelectric leg geometry was determined to establish the size of the generator. NSA

N68-11503# Monsanto Research Corp., Everett, Mass. Boston Labs.

FIVE-KILOWATT HYDRAZINE/AIR FUEL CELL MODULES Final Technical Report, 9 Apr. 1965–24 Jul. 1966

Robert E. Salathe and Peter L. Terry 10 Jun. 1967 35 p
(Contracts DA-44-009-AMC-983(T))
(MRB4026F; AD-659813)

Fuel cells based on an initial conceptual design for a 5-kilowatt N_2H_4/KOH/air fuel cell were constructed and operated. A development program was conducted in which factors causing operational difficulties were identified, and appropriate modifications of the design and choice of materials were then made. TAB

N68-11664 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
THE INTEGRAL CHARACTERISTICS OF A MAGNETOHYDRODYNAMIC GENERATOR WITH TWO PAIRS OF FINITE-LENGTH ELECTRODES
Ye. K. Kholshchevnikova *In its* J. of Appl. Mech. and Tech. Phys. 19 Apr. 1967 p 25–38 refs

The current distribution in an MHD channel with two pairs of finite-length electrodes along its walls separated by isolated sections was calculated. The potential difference between each pair of electrodes may vary. The channel is assumed to extend to infinity in the x direction with width 2δ in the y direction. The length of each electrode is l and the insulator 2λ. The magnetic Reynolds number is assumed to be small, and all induced currents are neglected. The magnetic field is given by $\bar{B} = (0,0,-B_0)$ and the velocity field by $\bar{V} = [V(y), 0,0]$, and σ is constant throughout the channel. It is further assumed that the current is symmetric relative to the x axis, and consequently the flow field is mapped from the z plane onto the τ plane. The currents I_1 and I_2 are defined and obtained in nondimensional forms. Several special cases are considered: (1) l and 2δ fixed and the insulation length approaching zero; (2) the effects of external loads on I_1, I_2, and the generator efficiency; and (3) the effect of channel geometry on I_1, I_2, and I. K.W.

N68-11928# Atomics International, Canoga Park, Calif.
NON-EQUILIBRIUM IONIZATION IN A POTASSIUM GAS MHD DEVICE Final Report
Charles A. Guderjahn Sep. 1967 58 p refs
(Contract AF 49(638)-01721)
(AI-67-138; AFOSR-67-2176; AD-660882)

A theoretical and experimental study of the plasma properties and fluid mechanisms of an annular magnetohydrodynamic generator operated in the Hall mode and driven by potassium gas is described. Nonequilibrium ionization is observed but is accompanied by concentration of current into streamers in the generator and reduction in the expected Hall voltage. As a consequence, the generator efficiency is reduced to zero. Author (TAB)

N68-12191 Atomics International, Canoga Park, Calif. Space Systems Dept.
NUCLEAR SPACE POWER SYSTEMS: REACTORS, CONVERSION EQUIPMENT, AND POWER SYSTEMS TECHNOLOGY
H. M. Dieckamp *In* AGARD Nucl., Thermal and Elec. Rocket Propulsion 1967 p 361–504 refs

The state of the art of nuclear power systems is reviewed, and the specific objectives of the SNAP program are delineated. Reactor heat sources are described in terms of nuclear fission, the chain reaction, and reactor design, and heat rejection equations are derived. Specific reactor requirements for a space power application are established, and a reactor-power conversion combination is selected. This is done by assessing the three major subsystems for nuclear space power plants: the reactor heat source, the power conversion cycle, and the waste heat radiator. The Rankine and Brayton cycles, thermoelectric, and thermionic power conversion systems are described, and the performance capabilities and limitations of each concept are discussed. The criteria for vehicle integration are defined. Design details and operational test data are given on the SNAP hydride reactor, SNAP 10A, and SNAP 2. M.G.J.

N68-12477# Jackson and Moreland, Inc., Boston, Mass.
REVIEW AND EVALUATION OF PROJECT FUEL CELL
H. F. White Dec. 1966 105 p
(Contract DI-14-01-001-500)
(OCR-17; PB-173765) CFSTI: HC$3.00/MF$0.65

Progress is reported in the development of a high efficiency, coal oxidation, solid electrolyte fuel cell. The technical potential of the fuel cell is evaluated, and a research program required to establish commercial feasibility is projected. Cost estimates are prepared for the research program including equipment, data collection, and evaluation of each work phase. The first commercial use of the fuel cell power system is projected, and a potential application is described which includes capital investment, operating costs, efficiency, and power cost. A compilation of report abstracts that were generated as a result of the study is included. C.T.C.

N68-12691# Argonne National Lab., Ill.
ANION-EXCHANGE BEHAVIOR OF LIGHT RARE EARTHS IN AQUEOUS METHANOL SOLUTIONS CONTAINING NEUTRAL NITRATES. 2: MACRO–MICRO SEPARATIONS
F. Molnar, A. Horvath, and V. A. Khalkin Jul. 1967 9 p refs Transl. into ENGLISH from Brennst.-Waerme-Kraft (Germany), v. 17, 1965 p 13–16
(ANL-TRANS-508) CFSTI: HC$3.00/MF$0.65

It has often been proposed that a liquid metal stream driven by a vapor stream of the same metal to high velocity be used for the application in MHD generators. The theoretical possibility of such an ejector was investigated from thermodynamical and fluid mechanical view points. The results indicate that the maximum of the attainable thermal efficiency is very low. Author (NSA)

N68-13094# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
STATUS AND PERSPECTIVES OF DEVELOPING MAGNETOHYDRODYNAMICS GENERATORS [SOSTOYANIYE I PERSPEKTIVY RAZVITIYA MAGNITOGIDRODINAMICHESKIKH GENERATOROV]
A. I. Moskuitin 18 Apr. 1967 42 p refs Transl. into ENGLISH from Akad. Nauk SSSR. Energ. Inst. Vopr. Razvitiya Energ. (USSR), 1964 p 56–79
(FTD-HT-66-378; AD-661771)

As is evident from the explained matter, work on MGD generators in world technology has sharply progressed in recent years. According to conduction generators with thermal equilibrium ionization, in the most theoretically and experimentally processed, powers of experimental samples were obtained of up to 1350 kw. Probably, in the relatively close future, experimental stations of thermal power will be built of the order of 150–250 mw, although there are still many problems to be solved, mainly pertaining to materials. In this connection, reports are presented on further increase in electro-conductivity, expansion of temperature boundaries, reduction of dimensions and increase in effectiveness on the basis of nonequilibrium ionization, pulsating flow of plasma and transition to electrodeless systems. Author (TAB)

N68-14541# California Univ., Livermore. Lawrence Radiation Lab.
FLUX-COMPRESSION GENERATORS
E. I. Bichenkov Sep. 1967 12 p refs Transl. into ENGLISH Akad. Nauk SSSR (Moscow), v. 174, no. 4, 1967 p 779–782
(UCRL-TRANS-10133) CFSTI: HC$3.00/MF$0.65

The results of work done at Hydrodynamics Institute of the Siberian Division of the USSR Academy of Sciences on the construction of explosion devices converting the energy of the explosives into the energy of a magnetic field are summarized. Several methods are described. NSA

N68-14585*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
PARAMETRIC ANALYSIS OF RADIOISOTOPE CASCADED THERMOELECTRIC GENERATORS

James T. Ward and Robert Ruch Washington Jan. 1968 27 p refs
(NASA-TM-X-1501) CFSTI: HC $3.00/MF $0.65 CSCL 18B

The generator consisted of a high-temperature silicon-germanium first stage and a lower-temperature lead telluride second stage was placed concentrically around a cylindrical fuel block. Heat was rejected from the outer surface of the generator shell; in most cases, fins were required to augment the heat rejection. The Si–Ge hot-junction temperature range was 1089° to 1255°K. The PbTe hot-junction temperature was fixed at 811°K and the PbTe cold-junction temperature varied from 422° to 700°K. The fuel-block length-diameter ratio varied from 0.5 to 10.0. The fuel-block-volume power-density range was 0.5 to 10.0 watts per cm^3. The generator power output was fixed at 250 watts electric. The performance of cascaded generators is also compared with the performance of single-stage Si–Ge generators. The results indicate that the cascaded generator operating at a Si–Ge hot-junction temperature of 1089°K had a minimum specific weight of 220 lbs per kilowatt electric (kW_e) at an efficiency of nearly 7%. For a Si–Ge hot-junction temperature of 1255°K, the minimum specific weight was 170 lbs per kWe with an efficiency of over 8%. The single-stage Si–Ge generator with a hot-junction temperature of 1255°K had a minimum specific weight of 100 lbs per kWe at an efficiency slightly below 6%. Author

N68-14630* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
PARAMETRIC ANALYSIS OF RADIOISOTOPE-THERMOELECTRIC GENERATORS
James J. Ward, William J. Bifano, and Larry S. Blair Washington Oct. 1967 22 p ref
(NASA-TM-X-1453) CFSTI: $3.00 CSCL 10B

A parametric analysis of a radioisotope-thermoelectric power generator is presented. A cylindrical heat-source geometry was assumed with either lead telluride or silicon-germanium thermoelectric elements located around the lateral surface of the fuel block. The heat source was treated parametrically by using the effective-volume power density of the heat source as a variable. Generator efficiency and specific weight were determined for fuel-block length-to-diameter ratios from 0.5 to 10.0, effective-volume power densities from 0.5 to 10.0 watts per cubic centimeter (W/cc), thermoelectric element hot-junction temperatures of 811°K for lead telluride and 1089° and 1255°K for silicon-germanium, and generator electrical output powers from 100 to 1000 watts. The results indicate that a substantial specific weight advantage is gained by employing silicon-germanium thermoelectric elements rather than lead telluride. In all cases, however, minimum specific weight is achieved at the lowest output power level, that is, 100 watts electric (W_e). For silicon-germanium generators having an output power of 100 W_e, the minimum specific weights are 120 and 88 lb/kW_e (54.5 and 40 kg/kW_e) for hot-junction temperatures of 1089° and 1255°K, respectively, with corresponding generator efficiencies of 4.1 and 5.8 percent. Author

N68-14746# Deutsche Versuchsanstalt fur Luft- und Raumfahrt, Stuttgart (West Germany).
OPTIMIZATION OF THE MHD-GENERATOR USING A LIQUID METAL AS A WORKING MEDIUM [DIE OPTIMIERUNG DES MIT EINEM FLUESSIGEN METALL BETRIEBENEN MHD-GENERATORS]
N. Kayukawa Nov. 1967 27 p refs In GERMAN; ENGLISH summary
(DLR-FB-67-71; DVL-683)

The optimization of a direct current and of an electrodeless induction type of MHD-power-generator, which are operated by using an incompressible fluid as a working medium is examined by employing the method of variational calculus for the total electrical power. The solutions of Euler's equations are the spatial constancy of the pressure for a d.c. MHD-generator and the spatial constancy of the flow velocity of an a.c. MHD-generator respectively. This performance of the fluid flow, that is the construction of the channel geometry, gives a physically attainable maximum efficiency. Author

N68-15230# Minnesota Mining and Mfg. Co., St. Paul, Minn.
560-WATT PORTABLE THERMOELECTRIC POWER MODULE Final Report
Thomas L. Nystrom, John H. Stauffer, and Edwin W. Pitcher Sep. 1967 57 p refs
(Contract DA-44-009-AMC-1607(T))
(AD-662770)

The objective of the research and development program is the design, fabrication, testing and delivery of a thermoelectric power module with the following principal requirements: Power - 560 watts at 28 volts dc; Weight - 35 pounds or less; Fuel - JP-4, CITE, or diesel fuels logistically available to the U.S. Army; Life - Continuous or intermittent operation of at least 1000 hours; Noise Level - Inaudible at a distance of 100 feet. A power module was delivered which demonstrates compliance with these requirements. Author (TAB)

N68-15499# Federal Power Commission, Washington, D. C. Bureau of Power.
DEVELOPMENT OF ELECTRICALLY POWERED VEHICLES
Feb. 1967 53 p refs Prepared for Comm. on Commerce, U. S. Senate
(PB-174982) CFSTI: HC$3.00/MF$0.65

Contents: History of electric vehicles; Present status of battery-powered vehicles; Electric energy storage systems; Electric vehicles; Public acceptance of the short-range electric vehicle; Electric power requirements; The electric vehicle and air pollution; Electric vehicle legislation. Author

N68-15525# Army Electronics Labs., Fort Monmouth, N. J. Electronic Components Lab.
FUEL CELL–BATTERY POWER SOURCES FOR ELECTRIC CARS
Galen R. Frysinger 1967 8 p Presented at Power Systems for Elec. Vehicles Symp., Columbia Univ., 6–8 Apr. 1967
(AD-662235)

Through the use of a fuel cell-battery hybrid power source all of the so-called vehicle battery problems can be overcome. This power source allows an electric vehicle to have: (1) Full range capability. (2) Excellent acceleration characteristics. (3) Very fast energy refuel. To achieve the performance outlined for the vehicle, requires the successful development of a 150 watt hour per pound molten electrolyte battery and a 20-35 lbs/KW hydrocarbon fuel cell. Research progress indicates that these goals should be achieved in operational hardware within the next five to ten years. Author (TAB)

N68-15641# Army Electronics Labs., Fort Monmouth, N. J. Electronic Components Lab.
FUEL CELL-ENERGY STORAGE HYBRID SYSTEMS FOR VEHICLES
Galen R. Frysinger 1967 27 p
(AD-662236)

Through the use of a fuel cell-battery hybrid power source all of the so called vehicle battery problems can be overcome. This power source allows an electric vehicle to have: (1) Full range capability. (2) Excellent acceleration characteristics. (3) Very fast energy refuel. To achieve the performance outlined for the military vehicle requires the successful development of a 150 watt hour per pound molten electrolyte battery and a 20-35 lbs/KW hydrocarbon fuel cell. Research progress indicates that these goals should be achieved in operational hardware within the next five to ten years. Author (TAB)

N68-15712# Army Electronics Labs., Fort Monmouth, N. J. Electronic Components Lab.
BATTERY–FUEL CELL SYSTEM
Galen R. Frysinger 1967 22 p Presented at 21st Ann. Power Sources Conf., Atlantic City, May 1967
(AD-662234)

Through the use of a fuel cell-battery hybrid power source for vehicular propulsion all of the battery problems can be overcome. This power source allows an electric vehicle to have: (1) full range capability, (2) excellent acceleration characteristics, and (3) use of conventional hydrocarbon fuels. To achieve the required performance depends upon the successful development of a 150 watt hour per pound molten electrolyte battery and a 20-35 pound per kilowatt hydrocarbon-air fuel cell. Research progress indicates that these goals should be achieved in operational hardware within the next five to ten years. Author (TAB)

N68-16286*# National Aeronautics and Space Administration, Washington, D. C.
MOTION OF CONDUCTING BODIES IN A MAGNETIC FIELD
Ya. Ya. Liyelpeter, ed. Feb. 1968 152 p refs Transl. into ENGLISH of the book "Dvizheniye Provodyashchikh Tel v Magnitnom Pole" Riga, Izd. Zinatne, 1966
(NASA-TT-F-460) CFSTI: HC$3.00/MF$0.65 CSCL 20I

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N68-16287*# National Aeronautics and Space Administration, Washington, D. C.
STATE OF THE THEORY OF MAGNETOHYDRODYNAMIC INDUCTION MACHINES WITH WORKING MEDIA OF LIQUID METAL
Ya. Ya. Liyelpeter *In its* Motion of Conducting Bodies in a Magnetic Field Feb. 1968 p 1–12 refs

Survey information is presented on the theory of magnetohydrodynamic (MHD) induction machines, with particular reference to analyzing the properties of a set of structural diagrams at preset specific loads and geometrical dimensions. The state of MHD induction machine electromagnetic theory is examined in some detail; this theory comprises the study of electromagnetic field structure in the working gap of the machine, as well as of processes in the magnetic and electrical circuits which determine the effective resistance and reactance of the windings. Also reviewed are studies pertaining to the plane linear MHD machine; the transverse edge effect in a plane MHD induction machine; magnetic field structure of an inductor of finite length; the theory of cylindrical MHD induction machines; and the motion of conducting bodies in pulsed electromagnetic fields. A reference bibliography is included. M.G.J.

N68-16288*# National Aeronautics and Space Administration, Washington, D. C.
ELECTROMAGNETIC PROCESSES IN AN IDEAL, INDUCTION MHD MACHINE
A. K. Veze and L. Ya. Ulmanis *In its* Motion of Conducting Bodies in a Magnetic Field Feb. 1968 p 13–37 refs

A summary is presented on the solutions for electromagnetic processes in a conductive band located in a traveling magnetic field of a flat inductor. It is assumed that the dimensions of the device are infinite in the direction of motion of the field and in the direction in which the electric current passes. Author

N68-16289*# National Aeonautics and Space Administration, Washington, D. C.
HIGHER SPATIAL HARMONICS OF THE MAGNETIC FIELD OF AN INDUCTION MHD MACHINE
Yu. Ya. Mikel'son *In its* Motion of Conducting Bodies in a Magnetic Field Feb. 1968 p 38–57 refs

Certain similarities between problems involved in the theory of asynchronous engines and induction magnetohydrodynamic (MHD) machines are noted, and the factors causing the deviation of the traveling magnetic field from a sinusoidal one are identified. Studies on higher spatial harmonics (HSH) are surveyed, and the results are given of investigations pertaining to the harmonics produced due to the spatial distribution of the multiphase stator winding, and their influence upon the motion of the rotor. Emphasis is placed on theoretical computations of HSH from the spatial distribution of the winding with a smooth steel surface of the stator; and the influence of an inductor surface having projections on the electromagnetic field distribution in a conductive band. Analytical computations are presented which may be used to obtain the coefficients for determining the distribution of the electromagnetic field, the force density, and Joule heat losses in the channel of an induction MHD machine. A reference bibliography is included. M.G.J.

N68-16290*# National Aeronautics and Space Administration, Washington, D. C.
TRANSVERSE EDGE EFFECT IN PLANE INDUCTION MAGNETOHYDRODYNAMIC MACHINES
A. Ya. Vilnitis *In its* Motion of Conducting Bodies in a Magnetic Field Feb. 1968 p 58–85 refs

The problem is formulated for the general case of a plane induction magnetohydrodynamic machine consisting of two plane stators (inductors) with m-phase winding, a plane channel with molten metal, and a thermal insulation channel. The factors influencing the transverse edge effect are described, and the theories and mathematical methods used in the computations are assessed. Solutions are given for infinitely wide model systems. An analysis is presented of the transverse edge effect in pure form, i.e., when there is no attenuation of the field in the clearance, which is achieved in the limit by the thin clearance between the inductors. Other theories pertaining to plane–parallel field in the clearance of the machine are reviewed. Consideration is also given to the transverse edge effect in induction pumps relative to the transition from an extremely thin plate between the inductors to a plate of finite thickness. A reference bibliography is included. M.G.J.

N68-16291*# National Aeronautics and Space Administration, Washington, D. C.
LONGITUDINAL EDGE EFFECT IN LINEAR INDUCTION MHD MACHINES

Ya. Ya. Valdmanis *In its* Motion of Conducting Bodies in a Magnetic Field Feb. 1968 p 85–98 refs

A state-of-the-art survey is presented on research in connection with the longitudinal edge effect in magnetohydrodynamic (MHD) machines. Allowance is made for their specific properties, such as an unlimited secondary circuit, and a practically infinite magnetic permeability of the magnetic circuit. It is assumed that the channel of molten metal is infinite, and the longitudinal effect is related to the finiteness of the inductor which is represented by a smooth magnetic circuit (in theoretical computations) with linear current loading given on its surface in the form of a traveling wave. Only the electrodynamic portion of the computation is investigated in each report considered, i.e., the molten metal of the secondary circuit is replaced by a solid metal moving at a constant velocity. The results are obtained from a solution of the Maxwell equations, in differential or integral forms, with the corresponding boundary conditions. Attention is focused on studies pertaining to the magnetic field of a finite inductor (longitudinal edge effect in a primary circuit), and to the magnetic field of a finite inductor with a secondary circuit. M.G.J.

N68-16292*# National Aeronautics and Space Administration, Washington, D. C.

PONDEROMOTIVE FORCES ACTING UPON CONDUCTIVE BODIES IN THE TRAVELING MAGNETIC FIELD OF A CYLINDRICAL INDUCTOR

Yu. K. Krumin' *In its* Motion of Conducting Bodies in a Magnetic Field Feb. 1968 p 99–121 refs

Problems encountered in designing a device using ponderomotive forces, which influence the conductive media located in the traveling magnetic field, are surveyed. Particular reference is made to the progress achieved in developing methods for calculating these forces, particularly their maximum values, as a function of other characteristics of the device. The problem areas considered pertain to the cylindrical inductor and its electromagnetic field; solutions to the problem of a conductive medium with a certain configuration placed in the inductor, and the corresponding solutions for the ponderomotive forces; methods of representing the results; the solid conductive cylinder in the field of an ideal inductor; the hollow conductive cylinder in the field of an ideal inductor; the solid cylinder having finite length in the field of an ideal inductor; the conductive cylinder in the field of a real inductor; and the conductive sphere in the field of a cylindrical inductor. M.G.J.

N68-17223*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

SPACE VEHICLE MISSILE POWER SUPPLIES Annotated Bibliography

Mildred Benton (George Washington Univ.) Redstone Arsenal Ala. Redstone Sci. Inform. Center Nov. 1967 226 p refs Prepared jointly with NASA and Army
(Contract DAAH01-67-C-1036(Z))
(NASA-TM-X-60877; RSIC-743) CFSTI: HC $3.00/MF $0.65 CSCL 10A

This annotated bibliography contains 700 citations from open literature on power supplies. It is oriented toward batteries, fuel cells, thermionics, thermoelectrics, nuclear energy sources, and other new concepts of direct energy conversion which may be adaptable to space vehicles. Author

N68-17793 Advisory Group for Aerospace Research and Development, Paris (France).

COMBUSTION AND PROPULSION

H. M. de Groff, ed., J. Fabri, ed., R. F. Hoglund, ed., T. F. Nagey, and M. E. Rumbaugh, Jr. London (New York), Gordon and Breach Sci. Publishers 1967 900 p refs In ENGLISH and FRENCH Presented at 6th Colloq. on Energy Sources and Energy Conversion, Cannes, France, 16–20 Mar. 1964
(AGARDograph-81)

In the panel papers presented, emphasis is focused on dynamic energy conversion, and the thermal, chemical, and radiant sources of direct energy conversion.

N68-17794 Atomic Energy Commission, Washington, D. C. Reactor Development Div.

NUCLEAR ENERGY SOURCE LIMITATIONS FOR DYNAMIC ENERGY CONVERSION SYSTEMS

Frank K. Pittman and Joseph D. Lafleur, Jr. *In* AGARD Combust. and Propulsion 1967 p 5–23 refs

The limitations which the nuclear energy source imposes on the dynamic power system fall into two categories. First, because of the premium which the space environment places on high temperature operation, materials throughout the system are called on to operate at high temperatures. Since the heat source must operate at the highest temperature of the cycle, the reactor fuel temperature is a potential limitation on cycle performance. Second, the nuclear radiation which accompanies the release of nuclear energy will require shielding or "hardening" to reduce the harmful effects on spacecraft components, and shielding to prevent injury to crews. The nuclear power plants will be the best, and in many cases, the only, means of meeting future space power needs. Therefore, these limitations and the associated development problems have been identified and are being solved. Author

N68-17796 Thompson Ramo Wooldridge, Inc., Cleveland, Ohio. Electromechanical Div.

RADIATOR DESIGN LIMITATIONS FOR DYNAMIC CONVERTERS

Alfred Koestel and Carmeron M. Smith *In* AGARD Combust. and Propulsion 1967 p 49–109 refs

This paper reviews the technology for design of radiators associated with dynamic converters in which the working fluid is condensed directly in the tubes of the radiator. In the first part of the paper the general design procedure and its optimization are discussed. Various constraints, namely, (1) condensing fluid mechanics; (2) radiation heat transfer from fins and tubes; and, (3) meteorite protection; are integrated through use of information flow charts indicating the sequence of computations. The appropriate equations and their source are noted. A method for estimating the optimum condensing temperature is explained and developed. The application of Lagrangian multipliers in the optimization of design is discussed. The second part of the paper describes the fluid mechanics of the condensing process. Single-phase boundary layer stability techniques are applied to two-phase flow mechanics for purposes of predicting the transition of flow regimes. Experimental data which correlate wetting and nonwetting characteristics in the forced convection condensation of mercury are presented. Critical mercury drop size measurements at incipient entrainment are described and the conditions for "fog flow" of entrained liquid are defined. In conclusion, a review of problem areas of interest to designers of condensers for space power systems is presented. This review includes gravity effects such as: (1) runback (slugging) instability in vertical tubes; (2) horizontal tube gravity effects, and (3) the Rayleigh–Taylor instability. Author

N68-17797 Oak Ridge National Lab., Tenn. Reactor Div.

HEAT TRANSFER LIMITATIONS FOR DYNAMIC CONVERTERS

A. P. Fraas *In* AGARD Combust. and Propulsion 1967 p 111–134 refs

Heat transfer considerations are major limiting factors in

the design, development, and operation of dynamic conversion systems for space power plants. The nature of these limitations varies with the component. For example, in the heat source–whether nuclear or solar–thermal conduction affects the thermal stresses, thermal distortion, and local hot spots. These factors are likely to limit the practicable power density in the heat source to a lower value than might be permitted by the obvious problem of heat transfer from the heated solid surface to the fluid cooling it. The latter is likely not to be a difficult problem except for local hot spots caused by poor flow distribution or the like. Other heat transfer limitations include problems in the boilers and condensers for Rankine cycle systems and heat conduction, emission, and reflection in the radiator. This paper presents some typical examples of these problems that are particularly likely to be determining factors in the design of turbine-generator space power plants. Author

N68-17799 Societe Hispano-Suiza, Bois-Colombes (France).
THERMODYNAMIC ASPECTS IN TWO PHASES FOR SPACE APPLICATIONS [THERMODYNAMIQUE DU CYCLE A DEAUX PHASES POUR APPLICATIONS SPATIALES]
J. Plotkowiak *In* AGARD Combust. and Propulsion 1967 p 153–179 refs In FRENCH; ENGLISH summary

Study of the possible use of the Rankine cycle in gas turbines for space applications and definition of the lower power limit which would still provide good performances. Research of working fluids suitable for these engines. Analysis of losses and effect of irreversible processes within the various components of the power plant on the system efficiency. Technological limitation and possible development of a low-power turbocompressor unit using the Rankine cycle. Author

N68-17802 AiResearch Mfg. Co., Los Angeles, Calif.
WORKING GAS SELECTION FOR THE CLOSED BRAYTON CYCLE
John L. Mason *In* AGARD Combust. and Propulsion 1967 p 223–252 refs

Systems based on the Rankine cycle have received primary attention in the last decade for nuclear-turboelectric space power production in the kilowatt range. However, recent developments in high-temperature energy sources, continued progress in component efficiency and reliability coupled with liquid metal handling problems in Rankine cycle systems have caused a refocusing of attention on the Brayton cycle. The properties of the cycle working gas influence the design of all major components except the alternator. Gas selection indices are developed here for a representative Brayton cycle turbocomponent, the compressor, and a representative heat transfer component, the recuperator. Especially at low power levels, these selection indices indicate substantial advantages associated with use of helium-xenon gas mixtures. Such binary inert-gas working fluids provide outstandingly low Prandtl numbers along with variable molecular weights to meet turbomachinery design requirements at various power levels. Author

N68-17803 TRW Space Technology Labs., San Bernardino, Calif.
NUCLEAR SOURCE LIMITATIONS FOR DIRECT CONVERSION DEVICES
R. W. Bussard *In* AGARD Combust. and Propulsion 1967 p 257–277 refs

Nuclear energy sources from solid-fuel fission reactors to eventual fusion reactors are considered for application to direct conversion. Brief review of system operating requirements provides a background for assessment of the potentialities and inherent physical limitations of these sources for direct conversion. Emphasis is placed on the characteristics of solid-fuel and gaseous-fuel fission reactors for application to thermionic and MHD conversion systems. Author

N68-17805 Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
THERMODYNAMICS OF THERMIONIC ENERGY CONVERSION
W. B. Nottingham *In* AGARD Combust. and Propulsion 1967 p 317–335 refs

The contribution made to the understanding of thermionic energy conversion through thermodynamics is an example of one of the principal applications of this scientific discipline. First, it shows the broad outline of possibility and its bounds. It yields numerical results where details are not available. The next step toward the achievement of the practical application of the principle of energy conversion through thermionics demands a detailed understanding of many phenomena related to electron physics. A few of these may be enumerated as (1) properties of the thermionic emitter, (2) properties of the electron collector, and (3) ionization and excitation of gas (cesium) in the interelectrode space. Cesium vapor is most helpful as a substance in converter technology, since it adsorbs on refractory metal emitters such as tungsten or rhenium to lower the work-function and thus permits the emission of a high electron current density. Cesium is easily ionized by two methods: (1) contact with the heated emitter surface or (2) collision with high-energy electrons. The ions reduce or eliminate the space-charge limitation of the available current. The collector work-function is determined by its temperature, its base material and, most of all, by the adsorbed layer of cesium. Great names of electron physics are associated with the development of the fundamentals required for the understanding of thermionic energy conversion. These scientists include Richardson, von Laue, Langmuir, Schottky, Franck, Hertz, Fowler, and others. Voltage-current curves demonstrate quantitatively the two principal modes of converter operation which are the "passive" and the "ignited", and provide the experimental data. The analysis of these data depends on the insight furnished through the application of thermodynamics and statistics to this area of research. Author

N68-17808 Commissariat a l'Energie Atomique, Saclay (France).
ON THE BEHAVIOR OF ENERGY CONVERSION LEFT FROM VAPOR IONIZED BY FISSION PRODUCTS [SUR UN PROCEDE DE CONVERSION D'ENERGIE A PARTIR DE VAPEUR IONISEE PAR PRODUITS DE FISSION]
Siegfried Klein and Pierre Kraus *In* AGARD Combust. and Propulsion 1967 p 357–374 refs In FRENCH; ENGLISH summary

When two electrodes maintained at different temperatures are immersed in ionized vapor, a potential difference appears between them. Tests have been performed in a nuclear reactor channel where the predominating ionizing agent is constituted by the fission products released by a thin layer of uranium oxide. Experience has shown that in this conversion process the negative charge carriers are not constituted by electrons only but also by negative ions or negative droplets. Further experimentation should permit the development of these converters. Author

N68-17809 Northwestern Univ., Evanston, Ill. Gas Dynamics Lab.
THE DIAGNOSTICS OF PLASMAS
John A. Thornton, Richard C. Warder, Jr., and Ali Bulent Cambel *In* AGARD Combust. and Propulsion 1967 p 377–418 refs

In energy conversion processes, both natural and man-made plasmas may be used to advantage. However, regardless of origin, it is necessary to know the properties of plasmas before reliable energy conversion devices can be designed and constructed. It is the purpose of this paper to highlight the theoretical considerations underlying plasma diagnostic techniques used in the gas dynamics laboratory in conjunction with a variety of plasma generation facilities. Author

N68-17810 Purdue Univ., Lafayette, Ind.
THERMODYNAMICS OF MHD ENERGY CONVERSION
Harold M. DeGroff and Richard F. Hoglund *In* AGARD Combust. and Propulsion 1967 p 419–475 refs

Previous theoretical and experimental work is reviewed with an over-all view of accessing the accuracy to which the performance of MHD Energy Conversion devices can be predicted. Both open- and closed-cycle linear magnetohydrodynamic generators are discussed. The recent progress made in open-cycle generators, with combustion reactions serving as the heat source, is described. Equilibrium thermodynamics is used to determine the theoretical performance of these generators. Particular attention is given to the loss mechanisms at the edges of the field regions and through the wall and electrode boundary layers. Existing experimental results are compared with the theoretical predictions. Major engineering problems are pointed out and discussed. In the case of closed-cycle generators, successful operation depends upon achievement of adequate electrical conductivity at relatively low temperatures. The most promising approach is through non-equilibrium ionization. The thermodynamic energy exchange processes which govern the extent of non-equilibrium ionization are discussed. Future prospects for development and key research areas pertinent to closed-cycle MHD power generation are described. Author

N68-17811 Newcastle Univ. (England). Dept. of Chemical Engineering.
NON-EQUILIBRIUM MODES OF MHD CONVERTERS
Ian Fells *In* AGARD Combust. and Propulsion 1967 p 477–500 refs

The classical linear flow, crossed field MHD generator can be made to operate with about ten per cent conversion efficiency but has inherent defects. Probably the most serious problems stem from the high temperatures necessary to maintain the conductivity of the driver gas stream by thermal (i.e. usually equilibrium) ionization of seed material introduced into the gas stream. In open cycle systems failure of electrode and duct materials occur, and heat transfer to the magnet system causes loss of efficiency. Breakdown of the electrical insulation properties of the refractories also takes place. In closed cycle systems using a nuclear pile as heat source, the temperatures required for thermal ionization are unlikely to be realized in present or future designs of piles. A variety of approaches to the problem can be adopted. The reaction zones of hydrocarbon flames exhibit marked departure from equilibrium and, associated with this, ionization levels one million times greater than the predicted equilibrium values. This process is incompletely understood but phased combustion aimed at promoting this effect can lead to systems in which seed material is unnecessary. Oscillating combustion systems operating at both low and high frequencies lead to periodic high ionization levels with a low time averaged temperature. Combustion driven detonations can be maintained in various modes; the spinning mode seems particularly useful for MHD power generation. In addition to lowering the time averaged temperature, the operation of pulsed systems makes possible the generation of alternating rather than direct current. This type of system can be further elaborated by the design of linked cycle systems in which the conductivity generating process is linked to, but not the same as, the driving cycle. The freezing of equilibrium during expansion can lead to high conductivity at lower temperatures; such an effect is applicable to closed as well as open cycle systems. Author

N68-17812 International Research and Development Co. Ltd. Newcastle (England).
A NON-EQUILIBRIUM ELECTRON MODE FOR KILOWATT RANGE MPD SPACE POWER
I. R. McNab *In* AGARD Combust. and Propulsion 1967 p 501–515 refs

Many techniques for producing extra-thermal ionization in magnetoplasma-dynamic (MPD) generators are currently under investigation in the hope that reductions in the operating temperature of these generators will result. This is particularly important in the nuclear closed-cycle concept, which is of interest for space power systems, where the available gas temperature is limited by foreseeable nuclear reactor developments. One method of producing electron concentrations considerably greater than for thermal equilibrium is to rapidly expand the working fluid by means of a nozzle. This effect is investigated here, particular attention being paid to its influence on MPD generators in the range 10–100 kw output. Author

N68-17813 Naples Univ. (Italy).
GENERALIZED SAHA EQUATION FOR NON-EQUILIBRIUM TWO TEMPERATURE PLASMAS
R. Monti and L. G. Napolitano *In* AGARD Combust. and Propulsion 1967 p 517–537 refs
(Contract AF 61(952)-548)

The present work is intended as a higher approximation with respect to the theory which proposes the use of the Saha equilibrium equation based on the electron temperature; in the present analysis both electrons and atoms temperature are taken into account for the calculation of the equilibrium electron concentration. A thermodynamical analysis of a ternary plasma (composed by one species of atoms, one species of ions and electrons) is presented and the components of the mixture are considered ideal gases. The state equations of the mixture, considered as thermodynamic system with four degrees of freedom, are written therefrom obtaining the explicit expressions of the affinities (Ai) for the rate processes (i.e., ionization, A_1 and thermalization A_2). The usual form of the Saha equations is recovered when one sets $A_1 = A_2 = 0$ (conditions of "full" equilibrium). The generalized form of the Saha's equation is obtained when one lets only $A_1 = 0$, thus obtaining, upon the acceptable hypothesis of thermodynamic stability, an explicit expression relating the degree of ionization (α) to the three remaining state parameters of the mixture. As an application of this theory the electrical conductivity has been calculated under a number of suitable simplifying hypotheses, as a function of the plasma pressure and temperatures. The correlation of the available experimental results appears to be improved with respect to other more simplified theories. Author

N68-17814 Air Force Systems Command, Wright-Patterson AFB, Ohio.
POTENTIALITIES OF DIRECT ELECTRO FLUID DYNAMIC ENERGY CONVERSION PROCESSES FOR POWER GENERATION, PART A
Hans von Ohain and Frank Wattendorf *In* AGARD Combust. and Propulsion 1967 p 541–561 refs

Two promising fields for the direct conversion of fluid dynamic energy into electrical energy are magneto-fluid dynamics (MFD) and electro-fluid dynamics (EFD). The major research effort to date has been in MFD processes, whereby the fluid dynamic energy of an electrically conductive medium in a thermodynamic cycle is transformed into electrical energy by passing through a magnetic field. The present paper is devoted to EFD conversion, whereby the fluid dynamic energy of a working medium containing ions or charged colloids is transformed into electrical energy by passing through an electrostatic field. Therefore, we see that EFD is not in the strict sense a member of the MFD family, but that both are members of a broader family. However, we do not consider EFD as a competitor to MFD, but rather as prospective complement in the energy conversion spectrum. EFD processes are characterized by low current density and high voltage. While the power density is lower than that indicated for MFD, the power-to-weight ratio may still prove favorable, due to the lack of need for heavy magnetic equipment. Author

N68-17815 Air Force Systems Command, Wright-Patterson AFB, Ohio.
PERFORMANCE CHARACTERISTICS OF ELECTRO-FLUID DYNAMIC ENERGY CONVERSION PROCESSES EMPLOYING VISCOVS COUPLING, PART B
Maurice O. Lawson *In* AGARD Combust. and Propulsion 1967 p 563-580 refs

In this study, the performance characteristics of electro-fluid dynamic energy conversion processes employing viscous coupling between the neutral molecules and the electrically charged particles are determined; specifically, the conversion efficiency and other electro-fluid dynamic performance values, including the effects of the physical properties of the working medium, the influence of geometric parameters, and scaling. Author

N68-17816 Air Force Systems Command, Wright-Patterson AFB, Ohio.
PERFORMANCE CHARACTERISTICS OF ELECTRO-BALLISTIC GENERATORS, PART C
Seigfried Hasinger *In* AGARD Combust. and Propulsion 1967 p 581–601 refs

For the stubby type particle beam, the typical electric field pattern is essentially that which exists between two infinite plane parallel electrodes. Space charge effects limit the electric power density in this case. For the slender type beam, the presence of radial field components greatly reduces these space charge effects. However, the beam spread caused by the radial field components again limits the power density. Calculations have shown that the effects of these limitations on the generator performance are quite similar in each case. The slender beam allows a several times larger power density referred to the initial beam diameter, however, with the beam spread taken into account, the power density is correspondingly lower. Thus performance derived for the infinite plane parallel case can be considered generally characteristics for the ballistic generator. Author

N68-17817 Air Force Systems Command, Wright-Patterson AFB, Ohio.
ION GENERATION BY CORONA DISCHARGE FOR ELECTRO-FLUID ENERGY CONVERSION PROCESSES, PART D
Maurice O. Lawson *In* AGARD Combust. and Propulsion 1967 p 603-612 refs

Corona discharge configurations are presented and research results are discussed. These configurations enable simultaneous employment of more than one working medium (e.g. gas and vapor for the formation of charged colloids). Also, these electrode configurations do not require an electrical power input for the ion generation, rather, the ionization energy is extracted from the available fluid dynamic energy of the working medium. Theoretical approaches and numerical calculations determining the unipolar ion current as functions of pressure, speed, ion or colloid mobility, physical properties of the working medium, and geometric parameters including geometric scaling are presented and compared with the results of an experimental investigation. Author

N68-17818 Air Force Systems Command, Wright-Patterson AFB, Ohio.
EXPERIMENTAL TECHNIQUES IN ELECTRO FLUID DYNAMIC ENERGY CONVERSION RESEARCH, PART E
Michael Hawes *In* AGARD Combust. and Propulsion 1967 p 613–630

The purpose of this study is to discuss experimental equipment and testing methods for electro-fluid dynamic power generation. The major topics of experimental research which are under study are as follows: (1) Closed-cycle or simulated closed-cycle operation. (Included are investigations on fluid-dynamic energy transfer from a supersonic jet of high molecular weight to a recirculating gas of low molecular weight; the mass flow of the supersonic jet being small in comparison to that of the recirculating gas.) (2) Methods of generation of ions or charged colloids of one polarity employing corona discharge. (3) Effects of the geometric configuration of the conversion section and determination of scaling characteristics. (4) Effects of variation in pressure in the conversion section. (5) Equipment and instrumentation for high voltage, low current, power measurements. These research topics influenced the design of the major components of the test apparatus and the testing methods which will be described in this paper. Author

N68-17819 Politechnico di Torino (Italy).
THERMODYNAMICS OF THERMOELECTRIC CONVERSION
V. Ferro *In* AGARD Combust. and Propulsion 1967 p 633-649 refs

After an examination of the experimental thermoelectric phenomena, their interpretation and correlation is made, according to the thermodynamic theory of irreversible processes. The case is then considered of an ideal thermoelectric generator, operating at optimum efficiency or at maximum electric power output conditions. Author

N68-17820 Advisory Group for Aerospace Research and Development, Paris (France).
HIGH-TEMPERATURE THERMOELECTRIC MATERIAL LIMITATIONS
C. M. Kelley and G. C. Szego *In its* Combust. and Propulsion 1967 p 651–677 refs

The characteristics of materials set many limits on their use in thermoelectric generators, the limiting factors varying in importance from one material to another. The Seebeck generator demands an extrinsic or mixed valence semiconductor. All semiconductors are limited by vapor or decomposition pressure at sufficiently high temperatures. This may be roughly estimated from the heat and entropy of vaporization, related in turn to structure and bond strength. The relation of bond strength to band gap is very approximate as presently known. Certain mixed valence semiconductors have shown adequate thermoelectric properties in the liquid state. The modules are most frequently limited by the mechanical stability of the contacts. Spring loading for high-temperature application requires some device complications. Radiative heat transfer need not be a serious problem below 1800°K. Above this temperature it may seriously impair efficiency. Because of the limited range of peak performance of individual materials, efficient devices will require graded materials or some degree of staging. At high temperatures the materials stability problem will force this to be staging. Over-all it appears that thermoelectric devices may be ultimately developed to operate at temperatures as high as 2000°K. Author

N68-17821 Admiralty Materials Lab., Poole (England).
FUEL CELL REACTANT PROPERTIES
R. G. H. Watson *In* AGARD Combust. and Propulsion 1967 p 681–707 refs

The fuel cell is considered as a chemical energy converter and the components which contribute to its important dimensions are discussed. The performance of the fuel cell system is related to the properties of its reacting components and the contribution they make to the various sources of energy loss. The values of some of these properties are readily accessible, such as the density and energy content of a fuel, which help to determine the maximum specific energy content of a fuel cell system. Other properties, which related to energy losses, and determine cell efficiency from which the actual specific energy content is determined, may be a function of a particular cell design. For instance the amount of polarization due to slow fuel electrode reaction will involve a wide range of properties including those of

electrode and fuel materials, at the cell conditions used. The reactant properties that are useful in fuel cell system design are derived in this discussion and concern the fuel, oxidant and exhaust products, and the electrodes and electrolyte. Appropriate values are tabulated and used to illustrate factors in cell design. Areas of apparent ignorance are discussed in relation to the need for further work. Author

N68-17823 Pennsylvania Univ., Philadelphia. Electrochemistry Lab.

ELECTROCHEMICAL CATALYSIS

J. O'M. Bockris and H. Wroblowa *In* AGARD Combust. and Propulsion 1967 p 717-767 refs

The factors affecting the rates of chemical and electrochemical reactions are discussed. The differences between chemical and electrochemical catalysis arising from the existence of the applied field and from the presence of solvent are shown from the theoretical and experimental points of view. A review of the possible ways to enhance electrocatalysis is presented. The mechanisms of several electrode reactions (oxidation of hydrogen, hydro-carbons, oxalic acid, oxygen reduction) pertinent to fuel cell reactions are discussed in detail, as a prerequisite to all catalytic considerations. A crude attempt is made to formulate some theory of the mechanism of catalysis, on the basis of an experimental comparison of the reaction rates on various catalysts of hydrogen and oxygen evolution and of ethylene oxidation. Needed trends in research are indicated. Author

N68-17824 Western Reserve Univ., Cleveland, Ohio.

KINETIC FACTORS IN FUEL CELL SYSTEMS: THE OXYGEN ELECTRODE

Ernest Yeager and Akiya Kozawa *In* AGARD Combust. and Propulsion 1967 p 769-793 refs

The oxygen electrode occupies a unique position with respect to fuel cells since it is the cathode of virtually all practical fuel cell systems. Experimental studies of the reduction of oxygen on porous carbon and metal electrodes of the types used as cathodes in aqueous fuel cells support the conclusion that the reduction proceeds through a peroxide intermediate. Significant concentrations of peroxide may accumulate in the solution adjacent to the cathode surface in operation at higher current densities. While the reduction of molecular oxygen to peroxide in alkaline solutions is characterized by relatively low polarization on most cathodes in aqueous low-temperature fuel cells, the subsequent reduction of the peroxide usually is very irreversible. An immediate consequence is that most low-temperature fuel cells, even at low current densities, operate at substantially less than the cell voltage predicted thermodynamically on the basis of the complete four-electron reduction of oxygen. The results of various studies of the oxygen-peroxide couple on carbon, graphite, lithiated nickel oxide, and platinum are summarized with emphasis on the dependence of the results on electrode composition, surface preparation, pH, and electrolyte composition. Some of the implications of these fundamental studies in the optimization of oxygen cathodes for aqueous fuel cells are discussed. Author

N63-17825 General Motors Corp., Dayton, Ohio. Allison Div.

THERMALLY REGENERATIVE FUEL CELLS

R E Henderson *In* AGARD Combust. and Propulsion 1967 p 795-809 refs

The thermally regenerative fuel cell is discussed in terms of modes of regeneration. Electrothermal as well as thermal regeneration schemes are described. The thermodynamic cycle is analyzed from the standpoint of reversible thermodynamics. A limiting efficiency is thereby calculated. Certain irreversible steps such as the voltage drop at the fuel cell and heat exchanger inefficiencies are considered from the standpoint of cycle efficiency. A practical system, namely, the K-Hg system is discussed in light of fuel cell data and boiler separator data. Space power system weights for such a system are estimated on the basis of this data. The various components of such a system are itemized and discussed from the standpoint of anticipated future developments Author

N68-17826* National Aeronautics and Space Administration, Washington, D. C.

THERMODYNAMICS AND APPLICATIONS OF BIOELECTRO-CHEMICAL ENERGY CONVERSION SYSTEMS

Michael G. Del Duca and John M. Fuscoe *In* AGARD Combust. and Propulsion 1967 p 811-839 refs

Bioelectrochemical energy conversion is the process of converting chemical free energy of biologically catalyzed reactions to electrical energy. Particular attention in the past two years has been directed to applying the results of biochemical research and development to this type of energy conversion. This paper considers these applications in a state-of-the-art review and presents a synopsis of suggested applications, ranging from the use of bioelectric currents to identify toxic materials and power human implanted cardiac pacemakers, to the generation of electric power in remote areas of the world. Author

N68-17828 Compagnie Generale de Telegraphie Sans Fil, Puteaux (France). Centre de Recherches Physico-Chimiques.

PHOTO-VOLTAIC CELLS WITH CONCENTRATORS [CELLULES PHOTO VOLTAIEQUES AVEC CONCENTRATEURS]

Pierre Leclerc *In* AGARD Combust. and Propulsion 1967 p 863-871

Reported is, the effect of development and operational parameters of a photo-diode on its photovoltaic efficiency Investigation of the effect of the series resistance on generator efficiency and of possible means of improving cell performance. Author

N68-17829 Laboratoire Central des Industries Electriques (France).

EFFECT OF A THERMOPHOTOVOLTAIC CONVERTER [REALISATION D'UN CONVERTISSEUR THERMOPHOTO-VOLTAIEQUE]

A. Fortini, Ph. Bauduin, and P. Sibillot *In* AGARD Combust. and Propulsion 1967 p 873-896 refs

Following a brief survey of the basic theory for the photovoltaic effect, a theoretical analysis is made of the influence of geometrical and electrical parameters defining a photovoltaic cell on the conversion efficiency for the conversion of luminous energy into electrical power. Study of spectral adaptation of the cell. Theoretical predictions and experimental data are compared. Author

N68-17830 Massachusetts Inst. of Tech., Cambridge.

P-I-N STRUCTURES FOR CONTROLLED SPECTRUM PHOTOVOLTAIC CONVERTERS

David C. White and Richard J. Schwartz *In* AGARD Combust and Propulsion 1967 p 897-922 refs

Improved efficiency in the photovoltaic conversion of radiant to electrical energy through the use of radiant energy sources with spectra matched to the electronic energy gap of the junction material was proposed by Pierre Aigrain in 1961. Investigation of systems for the control of the spectrum emitted from the source, the control of the transmitted spectra by selective filters, and the design of cells matched to the resulting spectrum have been undertaken in several laboratories since that date. The major activity has centered around 1500°C sources and germanium p-n junction cells. The factors to be considered in the design of such systems are: (1) Radiant source characteristics, (2) Spectral modification through the use of selective filters and reflectors (3) Collection

efficiency of the p–n junction. (4) The internal dissipation of energy due to series resistance within the cell. (5) The intensity of incident radiation required for efficient operation of the photovoltaic device. Considering the above factors an edge-irradiated P–I–N structure is analyzed and marked advantages are found because of higher output voltages, reduced series resistance, and improved collection efficiencies. This type of structure also possesses potential advantages for the conversion of high energy particles to electrical energy. Author

N68-18025# France. Ministere de l'Air, Paris.
CONTRIBUTION TO THE STUDY OF THE OXYGEN ELECTRODE [CONTRIBUTION A L'ETUDE DE L'ELECTRODE A OXYGENE]
Jean-Claude Sohm Serv. de Doc. Sci. et Tech. de l'Armament 1966 72 p refs In FRENCH *Its* Publ. Sci. et Tech. No. 425

Function of oxygen electrodes is examined in detail, and particular attention is given to the mechanism involved in the transport of oxygen in the neighborhood of the line separating the gas-electrolyte-electrode. At ordinary temperatures it is demonstrated that this mechanism is, more or less, the dissolution of the gas in the meniscus that constitutes the solution either in the solution or where it makes contact with the oxygen electrode. It is found that the local pressure rises with the depth and the accumulation of alkali in the meniscus, and it is noted that the current deposited by an oxygen electrode is a function of the length of the line that it realizes. An attempt to define the line current proved fruitless because the line current is almost independent of the geometry of the electrode and the radius of the menicus, and a qualitative discussion, therefore, is presented following the study of other electrodes of simple geometry. Applications for the development of fuel batteries are considered. Transl. by M.W.R.

N68-19019*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
CRITERIA FOR USE OF RANKINE-MHD SYSTEMS IN SPACE
Lester D. Nichols Washington 1966 24 p refs Presented at the Intern. Symp. on Magnetohydrodyn. Elec. Power Generation, Salzburg, Austria, 4–8 Jul. 1966
(NASA-TM-X-52191) CFSTI: HC$3.00/MF$0.65 CSCL 10B

A Rankine cycle that employs an MHD generator is being considered for use in space. These systems must be evaluated on the basis of minimum specific weight, which generally means minimum radiator area to reject the cycle waste heat. Limitations on materials, maximum available magnetic field strength, and the MHD power-generation process itself restrict the range of working fluid temperature and density. The maximum temperature (set by materials limitations) and the minimum radiator area criterion can be used to specify the operating temperature extremes. The operating pressure and density extremes are then determined by the choice of working fluid from the vapor-pressure curve. Since the conductivity increases with electron number density and decreases with increasing fluid density, it may be necessary to seed the working fluid to provide adequate electron concentration at the relatively high densities needed to heat the fluid. These considerations, coupled with the temperature requirements of the cycle, place restrictions on the choice of the seeded working fluid. Author

N68-19146*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
NUCLEAR THERMIONIC SPACE POWER SYSTEM CONCEPT EMPLOYING HEAT PIPES
Colin A. Heath and Edward Lantz Washington Mar. 1968 24 p refs
(NASA-TN-D-4299) CFSTI: HC$3.00/MF$0.65 CSCL 18N

A space power system employing out-of-pile thermionic diodes and using concentric heat pipes for both heating and cooling of these diodes has been examined. For an early application, the out-of-pile thermionic diode has some advantages over an in-pile system because it is removed from the reactor environment. Moreover, the heat pipe permits emitter temperatures that are not much less than the temperature of the fuel clad. Laboratory data on the performance of heat pipes has been examined and the results used to estimate reasonable performance levels for thermionic diodes which were consequently incorporated into a small, fast-spectrum nuclear reactor concept. Performance levels and system weights including shield weights, have been estimated from first order calculations. The overall system can have the advantage of the safety inherent in heat pipe redundancy and the improved performance available from components that are removed from the reactor environment. Author

N68-20884# Pratt and Whitney Aircraft, East Hartford, Conn.
FIVE HUNDRED-WATT INDIRECT HYDROCARBON-AIR FUEL CELL SYSTEMS Midterm Report, 10 Apr.–9 Sep. 1967
Calvin D. Greenwood Feb. 1968 47 p
(Contract DAAB07-67-C-0376)
(PWA-3211; ECOM-0376-1; AD-665435)

Work was undertaken to design, fabricate, test, and deliver two man-portable, 500-watt, indirect liquid hydrocarbon-air fuel cell powerplants. Studies showed that use of a boost pump would enable operation from a remote fuel source. Incorporation of a desulfurizer permits use of JP-4 or CITE. Automatic sequencing and control in both the hydrogen generator and the fuel cell assembly are activated from a single manual input signal; automatic shut-down occurs when off-design conditions are sensed. The units are being designed for compactness, minimum weight and sustained operation under Army field conditions. Incorporation of heat exchangers and a fan in the water recovery unit permits recovery of water from the exhaust gases of the hydrogen generator and fuel cell stack. Preliminary studies and breadboard simulation have indicated the feasibility of a design which meets these requirements. Author (TAB)

N68-21051# Northeastern Univ., Boston, Mass. Photochemistry and Spectroscopy Lab.
RESEARCH IN ENERGY CONVERSION Final Report, 1 Oct. 1963–30 Sep. 1966
Welville B. Nowak, Karl Weiss, and Robert N. Wiener 30 Sep. 1966 686 p refs
(Contract AF 19(628)-3836)
(AFCRL-67-0512; AD-665484)

CONTENTS:

N68-21052# Northeastern Univ., Boston, Mass.
INVESTIGATIONS IN THERMIONIC AND PHOTOVOLTAIC ENERGY CONVERSION
In its Res. in Energy Conversion 30 Sep. 1966 p 1–165 refs

Reported are results of studies on thermionic and photovoltaic energy conversion among which are cited studies of the response characteristics of silicon solar cells, the silicon single crystal film fabrication, energy conversion applications of hetero-junction diodes, thermodynamic aspects of photovoltaic devices, the properties of cathodes, and diffusion effects in silicon. S.C.W.

N68-21331# Kernforschungsanlage, Juelich (West Germany). Institut fuer Technische Physik.

APPLIED MAGNETOHYDRODYNAMICS, NO. 3 [ANGEWANDTE MAGNETOHYDRODYNAMIK, HEFT 3]

T. Bohn, S. Foerster, K. Grawatsch, Chr. Holzapfel, G. Kolb et al Dec. 1967 75 p refs In GERMAN

(JUL-510-TP) CFSTI: HC$3.00/MF$0.65

This paper describes design and construction of the ARGAS experimental magnetohydrodynamic generator at this nuclear research facility. The argon-operated generator is used to study the factors affecting specific energy conversion and the properties of dense, weakly ionized gases in general. Experiments with helium and neon as the operating gas are also considered. A detailed description is given of generator layout, heater elements, jet with diffuser and magnet, heat exchanger, cesium loop, compressors, gas purifiers, control arrangements, and instrumentation. Transl. by K.W.

N68-21439# General Electric Co., New York. Research and Development Center.

FUEL CELLS WITH MOLTEN-CARBONATE ELECTROLYTES

H. A. Liebhafsky and E. J. Cairns Jun. 1967 40 p refs

(Rept.-67-C-210)

Research efforts related to molten carbonate fuel cells are summarized by highlighting the work of several investigators, considering both aqueous and nonaqueous electrolytes, and predicting the future for practical batteries. It is noted that the great importance of natural gas has added significantly to the study of such fuel cells; and that with regard to power output, attainable gas utilization, and cell operating life, there appears to be a future for the high temperature fused carbonate cell. Economic feasibility of such batteries can be determined by conducting larger scale studies than are presently underway. M.W.R

N68-21480# Dornier-Werke G.m.b.H., Friedrichshafen (West Germany).

PROBLEMS OF ENERGY SUPPLY [PROBLEME DER ENERGIEVERSORGUNG]

W. Rasch *In* Tech. Hochschule Carolo Wilhelmina The Exploration of the Planet Jupiter Dec. 1967 p 128–146 ref

The feasibility and the advantages of using solar cells, radioisotope generators, fission electric cells, and thermionic converters as energy sources for Jupiter spacecraft are explored. Launch vehicle payload capacities, weight of the power systems, power densities, and the characteristics of important radioactive isotopes are evaluated. The resulting power efficiencies are applied to derive data transmission capabilities for the spacecraft. Transl. by K.W.

N68-21597*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.

THERMIONIC CONVERTER AND GENERATOR TESTS

P. Rouklove 1 Mar. 1968 15 p refs

(Contract NAS7-100)

(NASA-CR-94154; JPL-TR-32-1244) CFSTI: HC $3.00/MF $0.65 CSCL 10B

The results of tests of approximately 40 advanced-technology thermionic converters (all of planar geometry) and of 2 thermionic generators are presented, which were made to determine power output, maximum life, efficiency, and ability to withstand environmental stresses. Electron bombardment was used to simulate solar heating. In support of the converter and generator development ancillary experiments were performed to investigate (1) the reaction of alumina with molybdenum at high temperatures, (2) the accuracy of temperature measurements with different types of hohlraums with various L/D ratios, (3) the effects on the performance of a converter when enclosed in a generator configuration, and (4) the relationship between the shape of the emitter and that of the filaments used in the electron bombardment. Improved test equipment enabled simpler operation and, also, provided greater accuracy in diagnostic measurements. It was demonstrated that the units assembled have increased power and long-term life and can stand the stresses of the Atlas/Agena launch environment. Author

N68-21856# Technische Hochschule Stuttgart (West Germany). Institut fuer Kernenergetik.

RESULTS OF STUDIES ON THERMIONIC REACTOR SYSTEMS [ERGEBNISSE VON STUDIEN UEBER THERMIONIKREAKTOR SYSTEME]

R. Pruschek, S. Dagbjartsson, D. Emendoerfer, M. Groll, W. Haug et al [1968] 39 p refs In GERMAN; ENGLISH summary Presented at DGLR Symp. on Energy Provision in Space No. 2, Munich, 14 Mar. 1968

(Rept.-68-007) CFSTI: HC$3.00/MF$0.65

The following systems were studied: (1) thermal in-core thermionic reactors; (2) thermal double diode thermionic reactors; (3) fast in-core thermionic reactors; (4) fast heat pipe thermionic reactors; and (5) fast thermionic reactors with emitter heated by heat radiation. Such characteristics data as fissionable material requirements, power output, specific power, mass of components, and total mass are given. Problems of power flattening, long-time behavior, converter–nuclear heat source integration, and specific design features are discussed. K.W.

N68-21974 Joint Publications Research Service, Washington, D. C.

ISOTOPIC ELECTRIC POWER SOURCES FOR RADIOMETEOROLOGICAL STATIONS

G. M. Fradkin, V. M. Kodykov, A. I. Ragozinskiy, Ye. A. Kazakov, N. P. Korotkov et al *In its* Studies in Fuel Elem. and Radioact. Isotopes 18 Apr. 1968 p 15–19 refs (See N68-21972 12-22)

Thermoelectric means are being used to convert the thermal energy released during decay of radioactive isotopes into electrical energy as a source of electric power for radio meteorological stations in the Soviet Union. An experimental isotopic generator called Beta 1 is described that uses cesium 144 and has a power of 5 W; and various modifications to this generator are also considered. M.W.R.

N68-22013# Deutsche Versuchsanstalt fur Luft- und Raumfahrt, Stuttgart (West Germany). Inst. fuer Energiewandlung und Elektrische Antriebe.

ENERGY CONVERSION USING MAGNETOCALORIC AND ELECTROCALORIC EFFECTS [ENERGIEWANDLUNG MIT HILFE MAGNETOKALORISCHER UND ELEKTROKALORISCHER EFFEKTE]

Walter Peschka 1968 18 p refs In GERMAN Presented at the 2nd DGRR Symp. on Energy Supply in Interstellar Space, Munich, 14 Mar. 1968

(DGLR-68-005)

The principle of electrically conducting quasi-ferromagnetic liquids or suspensions is used to demonstrate that mechanical energy is also imparted to a non-ferromagnetic electrically conducting liquid when the working medium enters an alternating magnetic field in the vapor phase and then condenses. A portion of the heat required for vaporization occurs in the form of mechanical energy, i.e. increased pressure, and a magnetohydrodynamic (MHD) converter can be used to change the mechanical into electric energy. The process, in conjunction with regenerative heat exchangers and the MHD converter, can be adapted to the design of a thermodynamic loop which should be more efficient than condensing ejector systems without regenerative heat exchange. The application of electrocaloric effects in the conversion of heat into electric energy is briefly discussed. Transl. by K.W.

N68-23140# Army Electronics Labs., Fort Monmouth, N. J.
POWER SOURCES FOR ELECTRIC CARS
Galen R. Frysinger Jan. 1968 42 p
(ECOM-2929; AD-666773)

An extrapolation, based on extensive experience with battery and fuel cell power sources during various Army programs, is made into the future world of the electric car and speculates on the power sources most suited as the electrical energy source. The conclusion is that both the battery and the fuel cell have their place when combined uniquely in a hybrid configuration which by proper design can provide outstanding characteristics. Author (TAB)

N68-23346 Stanford Univ., Calif.
PERFORMANCE CHARACTERISTICS OF A COMBUSTION-DRIVEN MAGNETOGASDYNAMIC POWER GENERATOR
Karl Gardner Reseck (Ph.D. Thesis) 1966 232 p
Available from Univ. Microfilms: HC $10.60/MF $3.00 Order No. 67-4421

A magnetogasdynamic generator designed to obtain direct-current electrical power generation data under thermally steady-state conditions operates on the combustion products of ethyl alcohol, oxygen, nitrogen, and KOH seed. The active part of the generator is 19-1/2 inches in length with a cross-sectional area of 1-1/4 inches width by 4 inches transverse height. Thirteen pair of water-cooled molybdenum electrodes insulated by MgO brick form the walls of the gas duct. Flow conditions consist of a stoichiometric mixture with a total mass flow rate of 0.36 kg/sec. Magnetic induction levels of 0, 0.48, 1.36, 2.03 and 2.64 tesla are used. Electron mobility ranges from approximately 0.5 m^2/volt-sec in the hot gas core to 0.1 m^2/volt-sec along the cool electrode surfaces. Gas core temperatures are approximately 2570°K and 2750°K, and estimated wall surface temperatures range from 1000°K on the electrodes to 24°K on the sidewall brick. Test durations in excess of one hour were used. Dissert. Abstr.

N68-24189# Siemens-Schuckertwerke A.G., Erlangen (West Germany).
DEVELOPMENT OF A THERMOELECTRIC CONVERTER FOR A NUCLEAR ENERGY SYSTEM [ENTWICKLUNG EINES THERMOELEKTRISCHEN KONVERTERS FUER EIN NUKLEARES ENERGIEVERSORGUNGSSYSTEM]
E. V. Szabo Feb. 1968 69 p refs In GERMAN; ENGLISH summary Sponsored by Bundesmin. fuer Wiss. Forschung
(BMWF-FBW-68-10) CFSTI: HC $3.00/MF $0.65

During the development of a thermoelectric converter for a nuclear energy supply system recently studies were made of the production of semiconductors by sintering, the electrical conductivity of shoe materials, the compressive strength of complete generators components and the electrical insulation and fixing elements on the hot and cold side. The focal point of the work was the design of a converter featuring an alternatingly stacked ring-tube system for the hot and cold side with modular generator elements and heat transfer by liquid metal in a counter-flow arrangement. Advantages: simple assembly and wiring, uniform pressure on the modules and simple matching to the power requirements by extension of the system. Author

N68-24455*# General Electric Co., Philadelphia, Pa. Missile and Space Div.
NIMBUS 2: PHOTOVOLTAIC POWER SYSTEMS ON FLIGHT SPACECRAFT
K. F. Merten, K. L. Hanson, and W. J. Schlotter 23 Feb. 1968 519 p refs
(Contract NAS7-547)
(NASA-CR-62045; Doc.-68SD4222) CFSTI: HC $3.00/MF $0.65 CSCL 10B

Design and performance of the photovoltaic power system in the Nimbus 2 spacecraft are detailed from the viewpoint of the needs of a power system design engineer. Following descriptions of the Nimbus project, the power system, and overall power system management, descriptions are given of the solar array, battery modules, electronics module, and other components. Design performance requirements are detailed in terms of the subsystems, solar array, battery, and electronics module. General environmental test requirements are included; and design qualification and/or acceptance requirements are given for the sensory ring components; stabilization and control subassembly and components; solar array component boards, motor and latching mechanism, platforms, and assembly; and the Nimbus A and Nimbus C spacecraft. The power system design qualification and flight acceptance test programs are detailed; ground test and flight performance are described; and electrical/electronic parts lists are included. Costs and significant technical problems are noted, as are the prediction of space output of the Nimbus 2 solar array and effects of long term storage on the power system. M.W.R.

N68-25016# United Kingdom Atomic Energy Authority, Culham (England). Research Group.
ECONOMIC GENERATION OF POWER FROM THERMONUCLEAR FUSION
R. Carruthers, P. A. Davenport, and J. T. D. Mitchell Oct. 1967 33 p refs
(CLM-R-85) HMSO: 4s 6d

Plasma confinement systems are examined as to their potential for satisfying plasma power balance requirements for electrical power generation from the D-T fusion reaction. From this analysis a steady-state toroidal system is taken as a model and engineering parameters are identified defining (i) the form and size of an economic fusion reactor; and (ii) the plasma confinement parameters which must be satisfied. Capital and generation costs for a power station based on this model are estimated and it is shown that the generation costs compare favorably with those from other possible energy sources. A similar study of a D-D reactor indicates that this could provide an economic power source though the confinement parameters are more stringent. These economic studies are used to identify technological problems requiring investigation. Author (NSA)

N68-26381# Brookhaven National Lab., Upton, N. Y.
POLLUTION-FREE HYBRID FOSSIL-NUCLEAR FUELED MHD POWER CYCLE
M. Steinberg, J. R. Powell, M. Beller, and B. Manowitz [1968] 51 p refs Presented at the Conf. on Intern. Energy Conversion Eng., Denver Sponsored by AEC
(BNL-12319; CONF-660837-1) CFSTI: HC $3.00/MF $0.65

A hybrid power plant is developed based on a hydrogen-oxygen combustion MHD cycle. Hydrogen is generated by reforming fossil fuel with nuclear generated steam and oxygen is obtained from air in an air separation plant. Steam is injected into the combustion gases to control temperature and pressure through the duct. A preliminary parametric study of the cycle efficiency and MHD characteristics is made with steam and helium as diluent. Overall thermal efficiencies of 55% appear practical with nuclear energy contributing 38% and coal 62% to the power cycle. The hybrid system allows the use of fossil fuel in a pollution-free plant; conventional water and gas-cooled nuclear reactors can be utilized in an MHD cycle; thermal pollution is significantly decreased; a clean MHD duct is provided. Author (NSA)

N68-26537# Stanford Univ., Calif. Plasma Gasdynamics Lab.
BOUNDARY PHENOMENA IN MHD GENERATORS
Summary Report, 15 Feb. 1966-15 Feb. 1968
R. H. Eustis, E. Mitchner, and C. H. Kruger 15 Feb. 1968 20 p refs

(Contract AF 49(638)-1695)
(AFOSR-68-0859; AD-668454)

The investigations included in this research are as follows: Experiments on turbulent Hartmann flow in plasmas; Turbulence suppression in magnetohydrodynamic flows; Nonuniform electrical conduction in magnetohydrodynamic channels; Electrostatic probe theory and application in a high-temperature, collision-dominated, potassium-seeded argon plasma; Electron transport coefficients for two-temperature plasmas; Necessary conditions for the validity of the two-temperature plasma model; Experimental electrode current distributions in MHD channels; The influence of boundary layers on spectroscopic temperature measurements in MHD channels; Discharge characteristics in a seeded plasma flow. Author (TAB)

N68-28786# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
DIRECT COMPARISON OF VARIOUS FORMS OF ENERGY INTO ELECTRIC AND MECHANICAL POWER
G. N. Alekseyev 20 Jul. 1967 270 p refs Transl. into ENGLISH of the book "Neposredstvennoye Prevrashcheniye Razlichnykh Vidov Energii v Elektricheskuyu Mekhanicheskuyu" Moscow, Gosenergoizdat., 1963 p 1–336
(FTD-MT-64-355; AD-668263)

Contents: Direct conversion of chemical energy to electrical energy (Theory of fuel cells, Fuel cells with solid fuel, Fuel cells with gaseous fuel, Combined (solid-gas) fuel cells, Fuel cells with liquid fuel, Oxidizing reducing cells, Possibilities of application of fuel cells); Direct transformation of thermal energy into electrical and mechanical energy (Thermoelectric generators, Vacuum thermionic emission electric generators, Gas-filled thermionic emission electric generators, Plasma thermionic emission electric generators, Certain general questions for thermionic electric generators, Information on magnetohydrodynamics, Magnetohydrodynamic electric generators, Electrorocket motors); Direct transformation of nuclear energy into electrical and mechanical energy (Radioisotope electric generators, Nuclear radioisotope motors, Nuclear reactor electric generators, Nuclear reactor motors, Thermonuclear electric generators, Thermonuclear motors); Direct transformation of solar energy into electrical and mechanical energy (Solar electric generators, Solar sail, Photon rocket motor). TAB

N68-28714# Air Force Systems Command, Wright-Patterson AFB, Ohio. Air Force Aero Propulsion Lab.
PERFORMANCE FORECAST OF SELECTED STATIC ENERGY CONVERSION DEVICES
George W. Sherman, ed. and Lee Devol, ed. [1967] 1168 p refs Papers presented at the 29th Meeting of AGARD Propulsion and Energetics Panel, Liege, 12–16 Jun. 1967 Published for AGARD
CFSTI: HC $3.00/MF $0.65

Conference papers on static energy conversion devices for spacecraft power center on state-of-the-art reviews, technological developments, and performance predictions for batteries, fuel cells, and solar cells. For individual titles, see N68-28714 through N68-28748. M.G.J.

N68-28735# Air Force Systems Command, Wright-Patterson AFB, Ohio.
REGENERATIVE FUEL CELLS
Robert L. Kerr *In its* Performance Forecast of Selected Static Energy Conversion Devices [1967] p 658–715 refs

Problems which have delayed the development of the regenerative fuel cells are examined, and current technology and possible future advancements and applications are discussed. Attention is centered on the development potential of the thermally and electrically regenerative systems, as the weight, complexity, and low efficiency of the photo, nuclear, and redox systems discourage their use as space power supplies. It is pointed out that the thermally regenerative system is heavier than such dynamic devices as the Brayton cycle, especially at high power levels; however, the smaller radiator area requirement might make it suitable for missions where the radiator areas must be small and where low voltage direct current is needed. Although the specific weight, cycle life, volume, and efficiency of the electrically regenerative systems are well below those projected for high energy density batteries, such advantages as its ability to be sterilized, the easy state of charge indication, and its capability for operation in very long cycles may result in some applications such as the lunar surface operation missions. M.G.J.

N68-28738# AEG-Kernenergieanlagen, Hamburg (West Germany).
SYSTEMS CONSIDERATIONS USING FUEL CELLS
Eckehard F. Schmidt *In* AFSC Performance Forecast of Selected Static Energy Conversion Devices [1967] p 756–799 refs

As physically and chemically different types of fuel cells require different subsystems and different methods of system integration, the optimum design of power supply systems using fuel cells is discussed in the context of overall systems considerations. Various energy conversion methods are described, and an energy flow chart for fuel cell systems is discussed and compared with a flow chart of a diesel engine. Based on an assessment of energy conversion systems technology, the following order of priority for future development work is recommended: (1) technical improvement of procedures for the generation of hydrogen, (2) optimization of the auxiliary aggregates of the total system, and (3) development of fuel cells which can use raw hydrogen, and which are suitable for direct operation using cheap hydrocarbons. M.G.J.

N68-28748*# National Aeronautics and Space Administration, Washington, D. C.
FUTURE APPLICATIONS FOR STATIC ENERGY CONVERSION DEVICES
William H. Woodward *In* AFSC Performance Forecast of Selected Static Energy Conversion Devices [1967] p 1128–1154
CSCL 10A

As no one electric power generation system can meet all of the current and future space power requirements, eight static and dynamic systems are proposed as the systems of principal interest for the next 5 to 10 years. These include solar cells, isotope thermoelectric, isotope Brayton, reactor thermoelectric, reactor Rankine, reactor thermionic, batteries, and fuel cells. The probable power range and estimated technology ready dates for these systems are tabulated. Also listed are the average power level and duration for 12 potential unmanned science probe and orbiter missions, 9 potential manned missions, 8 potential unmanned application satellite missions, and 13 unmanned science landers and electric propulsion. It is estimated that an additional two to eight years of development will be needed to configure and qualify a specific system for a specific mission. M.G.J.

N68-29063# California Univ., Livermore. Lawrence Radiation Lab.
REPORT OF THE AD HOC PANEL ON FUSION RESEARCH ON LOW-BETA PLASMAS CONFINED IN OPEN-ENDED GEOMETRIES
T. K. Fowler, George Bekefi (MIT), Harry Dreicer (Los Alamos Sci. Lab., N. Mex.), G. E. Guest (Oak Ridge Natl. Lab., Tenn.) W. A. Perkins et al Mar. 1968 55 p refs Sponsored by AEC

(TID-24254) CFSTI: HC $3.00/MF $0.65

The committee reviewed the AEC open ended low beta plasma programs. Recommendations are discussed. NSA

N68-29921*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

NUCLEAR REACTOR SPACE POWER CONVERSION SYSTEMS

Roger F. Mather 1968 13 p Presented at Triann. Power Conf., Chicago, 8-10 Apr. 1968; Sponsored by AFOSR

(NASA-TM-X-52472) CFSTI: HC $3.00/MF $0.65 CSCL 18L

The principal systems now being investigated for converting heat from advanced nuclear reactors to electrical power for manned and unmanned spacecraft are discussed. These power conversion systems are the Rankine and Brayton turboalternator, magnetohydrodynamic, and thermionic. The basic operating principles and development status are described for each of these systems. System efficiencies, applicable power levels, development problems and other characteristics are briefly reviewed. Author

N68-29960*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

EXPERIMENTAL EVALUATION OF A VOLTAGE REGULATOR-EXCITER FOR A 15 KILOVOLT-AMPERE BRAYTON CYCLE ALTERNATOR

Gary Bollenbacher, Richard A. Edkin, and Dennis A. Perz Washington Aug. 1968 31 p refs

(NASA-TN-D-4697) CFSTI: HC $3.00/MF $0.65 CSCL 10A

A voltage regulator–exciter for a 15 kVA, 120/208 volts, 400 hertz alternator was experimentally evaluated. Emphasis was placed on the effect of the voltage regulator–exciter on the alternator performance. Specific items tested include the voltage regulator-exciter output capacity, its regulating capability, its effect on alternator waveshape, and its performance during transient and startup conditions. Author

N68-29990 Arkansas Univ., Fayetteville.

MAGNETOHYDRODYNAMIC STUDIES IN CYLINDRICAL SYSTEMS WITH POWER GENERATION APPLICATIONS

Martin Jack McCutcheon (Ph.D. Thesis) 1967 135 p

Available from Univ. Microfilms: HC $6.40/MF $3.00 Order No. 67-12884

The analysis of an annular induction magnetohydrodynamic generator from a field theory approach has been made in order to determine the phase impedance, the power factor and the performance characteristics for the model. The flow velocity is assumed constant in the analysis in order to uncouple the electromagnetic and hydrodynamic equations; the resulting solution accounts for the effects of curvature introduced by the geometry; both open channel flow and annular channel flow are considered. The generator phase impedance and power factor are presented in normalized scalable form in terms of the dimensions, excitation, and flow parameters. Several examples are given for both ionized gas and liquid metal flows which illustrate the performance levels which should be achieved with the generator. The results indicate that it may be feasible to construct an experimental generator with liquid metal as the working fluid. The development of a conductivity probe which can be used with an electric shock tube is described also. Dissert. Abstr.

N68-30018 West Virginia Univ., Morgantown.

CHARACTERISTICS OF A FINITE LENGTH M.H.D. TRAVELING WAVE CYLINDRICAL ACCELERATOR OR GENERATOR

Jerry Larkin Jester (Ph.D. Thesis) 1967 168 p

Available from Univ. Microfilms HC $7.80/MF $3.00 Order No. 67-11788

The primary aim of this paper is to determine the characteristics of an electrodeless cylindrical traveling wave accelerator of finite length. Previous work in M.H.D. power generation has shown, particularly for A.C. electrodeless generators, that a major portion of losses are due to fringing effects related to the small number of wavelengths of the device. From practical considerations, it is desirable to maintain a reasonably short length for the accelerator or generator; on the other hand, the efficiency of these devices is particularly sensitive to fringing effects associated with short lengths. This theoretical study determines quantitatively the electrical efficiency of an accelerator or generator of length comprising any integral or fractional number of wavelengths of the primary coil windings. In the second part of the paper a solution is presented which determines the correction coils necessary to eliminate first order fringing losses. Numerical results are shown in terms of four basic non-dimensional parameters; namely the slip factor, magnetic Reynolds number, radius of the tube, and, finally, the length of the device. Dissert. Abstr.

N68-30162# Oak Ridge National Lab., Tenn. Thermonuclear Div.

ON THE FEASIBILITY OF POWER BY NUCLEAR FUSION

D. J. Rose May 1968 156 p refs

(Contract W-7405-ENG-26)

(ORNL-TM-2204) CFSTI: HC $3.00/MF $0.65

Power from nuclear fusion will be feasible if certain plasma physics and engineering problems can be solved simultaneously: Equilibrium plasma properties discussed here are the thermalization rates between ions, electrons, and fusion α particles; fuel burnup fractions for given electron and ion temperatures, given injection or heating energies, and specified plasma environmental conditions. The effect of the presence of α-particles and of unequal particle temperatures on plasma pressure and reaction rate are calculated. Typical operating conditions for a variety of plasmas typical of open or closed magnetic confinement systems are shown. New solutions to outstanding engineering problems are indicated, viz: a cellular niobium vacuum wall, cooled with lithium or fused salt; a beryllium or BeO pebble-bed moderator, with added graphite; magnetic stress supports of titanium. Many subsidiary problems are discussed. It is shown that fusion systems with output in the order of 10,000 electric megawatts may be economically attractive; cost of the fusion system "core" lies between $10 and $20/kWe, depending upon circumstances. The desired operating parameters in an open-ended fusion system many be achieved if the plasma pressure is a substantial fraction of the magnetic pressure, but not otherwise, and the task will be difficult. Closed magnetic field configurations will be more attractive, provided stability and system size problems can be satisfactorily resolved. The relevance of the studies to present fusion research is indicated. Author (NSA)

N68-30330# Stichting voor Fundamenteel Onderzoek der Materie. Jutphaas (Netherlands). Instituut voor Plasma-Fysica.

PLASMA PRODUCTION AND HEATING BY LASER RADIATION

F. P. Kuepper Feb. 1968 28 p refs Sponsored by EURATOM

(NP-17453; Rept.-68-44)

A review of the present status of the theories and experiments of the production and heating of plasmas by laser radiation is given. This includes the problem of plasma confinement by external magnetic fields and by the laser radiation field itself. On the basis of the calculated models the possibility of the production of a thermonuclear plasma by laser radiation is discussed. It is concluded that with the present-day laser technology a thermonuclear plasma with a fusion energy release greater than the laser radiation energy may be produced on a time scale of nanoseconds. Author (NSA)

N68-30681# Utah Univ., Salt Lake City. Microwave Device and Physical Electronics Lab.
INVESTIGATION OF SYNCHRONOUS-WAVE RF TO DC CONVERSION Final Report, 1 Jun. 1966–31 Dec. 1967
D. C. Watson, R. W. Grow, and C. C. Johnson Apr. 1968 207 p refs
(Contract DA-28-043-AMC-02290(E))
(Rept.-4; UTEC-MD-68-006; ECOM-02290-F; AD-670083)

A device for converting microwave power into electrical power in either d-c or low frequency a-c form is investigated both theoretically and experimentally. An electron beam passes through a Cuccia coupler where it receives microwave power in the form of cyclotron rotation, then enters a region of decreasing magnetic field which accelerates the beam along the axis of rotation. The increased longitudinal kinetic energy is recovered as electric energy by a depressed collector. A simple kinematic analysis demonstrates that the Cuccia coupler can convert large amounts of microwave power into electron beam rotation. Although the inertial mass increase introduces some difficulties in Cuccia coupler operation, these difficulties are surmountable, and satisfactory coupler operation can be achieved for a relatively wide range of operating conditions. In most cases, relativistic operation is superior to that predicted classically. Four tubes and a gun-collector tester prototype were tested experimentally. The gun-collector tester prototype gave efficiencies from 36 percent to 75 percent. A fourth tube yielded measured efficiencies up to 34 percent, or when corrected to disregard cavity losses, up to 59 percent. Author (TAB)

N68-30760# California Univ., Livermore. Lawrence Radiation Lab.
CONCEPTUAL DESIGN OF A 10-MW SUB E NUCLEAR RANKINE SYSTEM FOR SPACE POWER
J. H. Pitts, ed., and C. E. Walter, ed. 30 Jan. 1968 43 p refs
(Contract W-7405-ENG-48)
(UCRL-50382) CFSTI: HC$3.00/MF$0.65

The conceptual design of a 10-MWe Rankine system for nuclear-electric space power is described. The system includes a compact nuclear reactor operating at 1650°K. The reactor design is based on uranium mononitride as the fuel, lithium as the coolant, and tungsten-25% rhenium as the structural material. An efficient heat-pipe radiator rejects waste heat at 1100°K. Overall system efficiency is 17.5%. Author (NSA)

N68-30811*# National Aeronautics and Space Administration, Washington, D. C.
HIGH TEMPERATURE ENERGY SYSTEMS WITH PLASMA REACTORS AND INDUCTIVE MAGNETOPLASMA-DYNAMIC CONVERTORS [HOCHTEMPERATUR-ENERGIESYSTEME UNTER VERWENDUNG VON PLASMAREAKTOREN UND INDUKTIVEN MAGNETOPLASMADYNAMISCHEN WANDLERN]
W. Peschka Jun. 1968 14 p refs Transl. into ENGLISH from Deut. Versuchanstalt fur Luft- und Raumfahrt, Inst. fur Energiewandlung und Elek. Antriebe (Stuttgart), Sep. 1967 Rept. DLR-FB-67-59
(NASA-TT-F-11825) CFSTI: HC$3.00/MF$0.65 CSCL 20I

This paper investigates possible future power generating equipment which operates with high temperature plasma as a working medium and subsequently with high power density. This temperature range requires reactors whose nuclear fuel is in the plasma state (fission or fusion reactors) coupled to magnetoplasma-dynamic generators acting as energy converters. Electrodeless MPD-generators with all their advantages can be successfully employed. The technological ramifications arising from the application of these high temperatures with respect to the reactors and the MPD-generators as well as to the heat release equipment are discussed. Author

N68-31042*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
DEVELOPMENT OF A 1200-HERTZ ALTERNATOR AND CONTROLS FOR SPACE POWER SYSTEMS
B. D. Ingle and C. S. Corcoran 1968 14 p refs Presented at the Intersoc. Energy Conversion Eng. Conf., Boulder, Colo., 13–16 Aug. 1968
(NASA-TM-X-52453) CFSTI: HC$3.00/MF$0.65 CSCL 10B

For a 1200-hertz Brayton energy conversion system having a useful load rating of 10 kWe, an alternator and the associated voltage and frequency controls were designed and tested. The unique features in the components are: (1) the 36,000-rpm solid-rotor alternator designed to accommodate gas bearings; (2) pulse-type voltage regulator which is synchronized with the line frequency; and (3) multiple parasitic-loading speed control. Author

N68-31544# Westinghouse Electric Corp., Lima, Ohio. Aerospace Electrical Div.
DESIGN STUDY (OF) ELECTRICAL COMPONENT TECHNOLOGY FOR 0.25 TO 10.0 MEGAWATT SPACE POWER SYSTEMS. PARAMETRIC DESIGN STUDY OF CANNED AC INDUCTION MOTORS
T. C. Allen 15 Dec. 1967 134 p refs
(Contract AT(04-3)-679)
(SAN-679-5; WAED-67.52E) CFSTI: HC$3.00/MF$0.65

Parametric studies of canned ac induction motors for prime movers of centrifugal pumps for space nuclear electric power plants utilizing the Rankine conversion cycle is presented. The parametric data is suitable to determine minimum system weight as a function of shaft horsepower rating, frequency, synchronous speed, voltage, and coolant temperature for ratings between 5 and 250 horsepower. Author (NSA)

N68-31787# Stanford Univ., Calif. Inst. for Plasma Research.
EXPERIMENTAL ELECTRODE CURRENT DISTRIBUTIONS IN MHD CHANNELS
J. L. Kurz Apr. 1968 127 p refs
(Contract AF 49(638)-1695)
(SU-IPR-230; AFOSR-68-1298; AD-670527)

The distribution of current on the electrodes of a single-pair MHD channel was investigated experimentally. The experiments were performed with a flowing, atmospheric-pressure, alkali-metal-seeded argon plasma at temperatures between 1980K and 2150K for Hall parameter values up to seven. Two electrode configurations were investigated; one with the electrodes projecting into the flowing plasma, the other with the electrodes flush with the channel wall. Qualification measurements showed that the plasma free-stream conditions were uniform across the channel and in agreement with equilibrium calculations. Results for the anode current distribution were in all cases in good agreement with the theoretical predictions. The cathode current distribution was found to agree less well with the predictions. It was observed that the cathode current distribution for flush electrodes was considerably more uniform than for projecting electrodes. The anode voltage drop was consistently a small fraction of the total applied voltage for both electrode configurations. In contrast, the cathode voltage drop for the flush electrode channel was about four times that for the projecting electrode channel and constituted nearly 50 per cent of the total applied voltage. The cathode voltage drop was found to correlate reasonably well with the Schottky equation. Measurements made of the root-mean-square voltage fluctuations between voltage probes were consistent with the presence of magnetoacoustic and electrothermal waves. Author (TAB)

N68-31910# California Univ., Livermore. Lawrence Radiation Lab.
ONE-DIMENSIONAL CALCULATIONS ON A FINITE-LENGTH

MHD INDUCTION GENERATOR
M. Heusinkveld 11 Apr. 1968 41 p refs Presented at the Symp. on Magnetohydrodyn. Elec. Power Generation, Warsaw
(Contract W-7405-ENG-48)
(UCRL-70795; Conf-680704-1) CFSTI: HC$3.00/MF$0.65

The problem of the finite length induction converter is solved in the slit channel approximation, in which the transverse magnetic field does not vary across the gap. The fluid channel is assumed to be infinitely wide, or infinite conductivity side shorting bars are assumed for a channel of finite width. Slug flow and scalar electrical conductivity of the channel fluid and sinusoidal time variation are assumed. The magnetic pole pieces with infinite magnetic permeability extend from $x = 0$ to $x = 1$. The basic equation for the total magnetic induction B_t is deduced from Faraday's law. Equations are obtained for electrical impedance of the excitation winding, hydrodynamic power input, real and reactive electrical power output, and the energy conversion efficiency. Predictions from this analysis are compared with experimental data from a linear converter model. Results of numerical calculations of the problem of a uniform traveling wave generator of finite length are presented. NSA

N68-31928# Avco-Everett Research Lab., Everett, Mass.
ELEVENTH AFOSR CONTRACTORS' MEETING ON NON-CHEMICAL ENERGETICS: SUMMARIES OF RESEARCH
G. S. Janes [1968] 41 p refs Meeting Held in Boston, 20-22 May 1968
(Contract AF 49(628)-1553)
(AFOSR-68-1377; AD-671149)

Subjects reported include plasma diagnostics, magnetohydrodynamics acceleration and power generation, high temperature plasma production and containment related to controlled fusion, and charged particle accelerators related to physical energeties processes in energy and power sources and conversion. Research principal investigators and their affiliations are identified. Author (TAB)

N68-32748# Westinghouse Electric Corp., Lima, Ohio. Aerospace Electrical Div.
DESIGN STUDY OF ELECTRICAL COMPONENT TECHNOLOGY FOR 0.25 TO 10.0 MEGAWATT SPACE POWER SYSTEMS. POWER CONDITIONING: PARAMETRIC SCREENING STUDY
E. F. Swiderski and John W. Gyurek 15 Sep. 1967 411 p refs
(Contract AT(04-3)-679)
(WAED67.45E; SAN-679-4) CFSTI: HC$3.00/MF$0.65

Results of the parametric studies to determine minimum system weight as a function of electrical component rating, voltage and frequency are presented on power conditioning and power distribution equipment for 0.25 to 10.0 MW space nuclear electric power plants utilizing the Rankine conversion cycle. The power conditioning and distribution equipment includes frequency changers, transformers, rectifiers, and transmission lines. The complete results on the parametric studies for the above equipment are presented. Author (NSA)

N68-34481# Westinghouse Electric Corp., Lima, Ohio.
ELECTRICAL COMPONENT TECHNOLOGY FOR 1/4 TO 10 MEGAWATT SPACE POWER
A. E. King, J. B. Fanger, and G. S. Leighton (AEC, Washington, D. C.) Aug. 1968 13 p refs Presented at 3d Ann. Intersoc. Energy Conversion Eng. Conf., Boulder, Colo., 13-16 Aug. 1968
(Contract AT(04-3)-674)
(CONF-680802-1) CFSTI: HC$3.00/MF$0.65

Analytical data are presented for electrical power system components in advanced high-temperature, postasium Rankine nuclear space power systems. Power level and coolant temperature were used as independent variables to define combined minimum weight, maximum efficiency configurations based on an extensive background in the development of high temperature electrical materials, ac generators and motors, and power conditioning equipment for space applications. The data presented forecast electrical power system component design limitations and envelopes of minimum weight designs relative to such major systems parameters as temperature, shaft speed, voltage and frequency. Representative missions were analyzed for purposes of defining the ranges and types of electrical power needs and corresponding components. Author (NSA)

N68-35232# Navy Space Systems Activity, Los Angeles, Calif.
SPACE POWER SUPPLY STUDY Final Report
Richard V. Silverman May 1968 178 p refs
(NSSA-R40-68-5; AD-672772)

This report presents the results of a parametric analysis, evaluation and comparison of space electrical power systems capable of meeting a set of mission requirements. The parameters include: continuous power (300 or 600 W), peak power (2, 3.5 or 5 kW), duty cycle (5%, 10% or 20%) and mission duration (1 to 12 months). The spacecraft is defined to be in a low circular polar orbit and the power systems are to be available in the 1970-1973 time frame. Six types of power systems (solar cell/battery, fuel cell, fuel cell/battery, solar cell/battery/fuel cell, solar cell/fuel cell, and radioisotope thermoelectric generators/battery) were evaluated for possible application to such missions. Evaluation and comparison criteria include mass, volume, procurement costs, reliability and spacecraft integration factors. Author (TAB)

N68-35442# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
PARAMETERS OF MAGNETOHYDRODYNAMIC (MHD)-GENERATORS TAKING INTO ACCOUNT IONIZATION INSTABILITY OF PLASMA [PARAMETRY MGD-GENERATOROV S UCHETOM IONIZATSIONNOY NEUSTOYCHIVOSTI PLAZMY]
V. A. Gurashvili, Yu Kareyev, and A. V. Nedospasov 6 Oct 1967 28 p refs Transl. into ENGLISH from IAE-1348 Rept.
(FTD-MT-24-205-67; AD-672686)

A discussion is given of calculations of MHD generators with unbalanced conductivity taking into account ionization instability. As a working medium argon and mercury vapor containing addition of cesium vapors are examined. Theory and experiment show that ionization instability is developed with such parameters of plasma which are assumed to be used in MHD generators with unbalanced conductivity. New approaches toward the selection of MHD generators are touched upon. Author (TAB)

N68-35663# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
INVESTIGATION OF SUPERSONIC RADIAL NOZZLES FOR MHD-GENERATORS [ISSLEDOVANIYE SVERKHZVUKOVYKH RADIAL'NYKH SOPEL DLYA MGD-GENERATOROV]
B. A. Tikhonov and V. R. Shevchenko 14 Oct. 1967 19 p ref Transl. into ENGLISH from Russian Rept. IAE-1347
(FTD-MT-24-208-67; IAE-1347; AD-672687)

Article discusses the results of the investigation of gas dynamics of radial (fan) supersonic nozzles. Experimental data are given on the influence of basic geometric dimensions of the radial nozzle on its gas-dynamic characteristics. Recommendations are given on the designing of shock-free radial nozzles with uniform field of speeds on the outlet. TAB

N68-35919# California Univ., Livermore. Lawrence Radiation Lab.
COMPUTATIONAL PROBLEMS IN PLASMA PHYSICS AND CONTROLLED THERMONUCLEAR RESEARCH
John Killeen 8 Jul. 1968 96 p
(Contract W-7405-eng-48)
(UCRL-71205) CFSTI: HC$3.00/MF$0.65
Numerical calculational methods for plasma physics are described for each of the following: pinch experiments, resistive instabilities, finite-β equilibria, Fokker–Planck equation, and the Vlasov equation. NSA

N68-37259*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
DESIGN AND PRELIMINARY OPERATION OF THE LEWIS MAGNETOHYDRODYNAMIC GENERATOR FACILITY
Lester D. Nichols, James L. Morgan, Lawrence A. Nagy, Joseph M. Lamberti, and Robert A. Ellson Washington Oct. 1968 26 p refs
(NASA-TN-D-4867) CFSTI: HC$3.00/MF$0.65 CSCL 14B
The closed loop facility has been designed to study the feasibility of an argon–cesium MHD generator. The construction details, performance, and some preliminary research data are discussed. The facility has operated for several hours at the following conditions: argon flow rate, 1.8 kg/sec; Mach number, 0.3 to 0.5; stagnation temperature, 2100°K. Thus far, open circuit voltages equal to 60 percent of theoretical value (at 50 V) were measured. In addition short circuit currents up to 0.8 A (per electrode pair) were measured. This is in agreement with the calculated value using equilibrium conductivity. Leakage currents prevented better performance. Author

N68-37342# Arkansas Univ., Fayetteville. Plasma Lab.
ENERGY TRANSFER PROBLEMS IN SUPERCONDUCTORS AND FLOWING PLASMAS Final Report
Denys O. Akhurst, Martin J. McCutcheon, and Melvin K. Anderson Oct. 1967 259 p refs
(Contract DA-01-021-AMC-12820(Z))
(UAPL-31; AD-673292)
The final report on energy transfer problems in superconductors and flowing plasmas describes theoretical and experimental studies of energy storage and transfer in cryogenics and magnetohydrodynamics. In the cryogenic studies, electrical energy is stored in superconducting coils and extracted with a 98% energy transfer efficiency. Theoretical support is given for the switching, storage and extraction results. In the magnetohydrodynamic studies, electrical energy is extracted from the high temperature plasma flow through a dc MHD generator. Included in the study is a survey of dc and ac MHD generators, an analysis of cylindrical ac MHD generators, and investigation of a pulsed induction ac MHD generator and the design and operation of a small scale dc MHD generator. Author (TAB)

N68-37410*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
RESEARCH AND ADVANCED CONCEPTS
In its Space Programs Sum. No. 37–51, Vol. 3 30 Jun. 1968 p 116–135 refs
Reported are research and advanced concepts related to the following: (1) laminarization in nozzle flow; (2) liquid-metal MHD (magnetohydrodynamic) power conversion; (3) the SE-20C thruster design; (4) radial distribution of enthalpy in a high temperature swirling flow; (5) effects of an applied, transverse magnetic field on heat transfer with swirling and nonswirling gas flow; and (6) effects of an applied, transverse magnetic field on wall pressure in a square channel. S.C.W.

N68-37951# Martin Co., Baltimore, Md. Nuclear Div.
SNAP 19, PHASE 3. VOLUME 3: GENERATOR DEVELOPMENTAL ASPECTS Final Report
May 1968 87 p refs
(Contract AT(30-1)-3607)
(MND-3607-239-3, V. 3) CFSTI: HC$3.00/MF$0.65
The purpose of SNAP-19 III Program is described. Thermoelectric couple development, component selection criteria and the module criterion are described. A description of development of advanced techniques for fuel handling, outgassing and leak testing generators is presented. Heater element and heater block development, including problems encountered and method of resolution are discussed. The configuration of generators tested, preparation for the tests and the tests; results of pre-endurance and endurance tests; evaluation of thermoelectric components and conclusions drawn from endurance tests are reviewed. Design features that provide reliability, and tests that provided reliability data are covered. The performance of Viton A as generator seals is discussed. Hot junction temperature measurement system, the problems experienced during its development and the means of problem resolution are discussed. Methods used in making neutron and gamma measurements, and spectra from these measurements are presented. The method of capsule support, problems encountered with support design and means by which problems were corrected are described. Author (NSA)

N68-38458# Institut fur Plasmaphysik G.m.b.H., Garching (West Germany).
THE EFFECT OF THE ELECTRODE GEOMETRY ON THE CURRENTS AND POTENTIALS IN MHD GENERATORS [EINFLUSS DER ELEKTRODENGEOMETRIE AUF STROEME UND SPANNUNGEN BEI MHD-GENERATOREN]
M. Salvat Feb. 1968 16 p refs In GERMAN; ENGLISH summary
(IPP-3/68) CFSTI: HC$3.00/MF$0.65
The effect of the electrode segmentation on the performance characteristics of MHD generators was found by means of simple physical considerations. Simple expressions are derived which give the efficiency of an MHD generator as a function of the geometry and the Hall parameter. Author

N69-10111*# Pennsylvania Univ., Philadelphia. Inst. for Direct Energy Conversion.
RESEARCH IN THE CONVERSION OF VARIOUS FORMS OF ENERGY BY UNCONVENTIONAL TECHNIQUES Status Report for Period Ending 30 Jun. 1968
Manfred Altman Jun. 1968 78 p refs
(NASA-CR-97473; INDEC-SR-14) Avail: CFSTI CSCL 20
A transient solution to the heat conduction equation in a three layer composite cylinder was developed assuming perfect thermal contact between interfaces. Thermoelectric power, Hall coefficient, electrical conductivity, microhardness, and optical reflection measurements were made on $CuCd_2InSe_4$ and $AgCd_2InTe_4$. Data on the structure of tungsten films, on the effect of gas pressure on structure, and on tunneling were analyzed and summarized. Five porous ceramics and two millipore membranes were analyzed to define thermal transpiration flow, isothermal permeability, and heat conductivity. MHD measurements were made using a conducting fluid of liquid Hg with Na metal additive to increase wettability. Definite positive effects from the shape of the Pt Fermi surface were obtained; the results explained a large part of the structure of the Pt micrograph. Experimental apparatus was assembled for the purpose of obtaining transient overpotential data of a redox system (K ferricyanide and K ferrocyanide) on a rotating disk. Progress in specific areas of fuel cell design and performance are summarized. B.P.

N69-10335* Heat Engineering and Supply Co., San Gabriel, Calif.
DESIGN AND MANUFACTURE OF PARASITIC LOAD RESISTORS FOR BRAYTON POWER CONVERSION SYSTEM Final Report
23 Jul. 1968 45 p
(Contract NAS3-10777)
(NASA-CR-72436) Avail: CFSTI CSCL 10B

Details are given on the design, manufacture and testing of Parasitic Load Resistors to dissipate 18 KWe electric power at 120 Volts and 1200 Hertz by converting the electrical energy to heat energy and radiating that energy to hard vacuum. Author

N69-11943# Joint Publications Research Service, Washington, D. C.
HEAT REGENERATION INJECTOR DESIGN EFFICIENCY AND SLOW PARAMETERS WEIGHED IN MHD INSTALLATIONS
28 Oct. 1968 61 p refs Transl. into ENGLISH from the book "Magnitogidro-Dinamicheskiy Metod Polucheniya Elektronenergii" Moscow, 1968 p 421–476
(JPRS-46752) Avail: CFSTI

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N69-11944# Joint Publications Research Service, Washington, D. C.
THE THERMODYNAMICS OF MULTISTAGE CYCLES OF MHD INSTALLATIONS WITH HEAT REGENERATION
E. E. Shpil'rayn et al *In its* Heat Regeneration Injector Design Efficiency and Slow Parameters Weighed in MHD Installation 28 Oct. 1968 p 1–10 refs
Avail: CFSTI

The present paper examines and analyzes the cycles of fluid-metal power installations with a single-component working fluid. It outlines the principal causes resulting in low efficiency of the cycle when there is multistage introduction of cold fluid (in the injector system). Multistage systems are proposed for both the injector and the separation method of heat regeneration, making it possible to operate the power installation within a wide range of dryness levels. It is shown that the effective efficiency coefficient in such cycles ranges from 12 to 14%. Author

N69-12307*# Toronto Univ. (Ontatio). Inst. for Aerospace Studies.
OPERATION OF AN MGD POWER GENERATOR Concluding Report, 1 Jun.–30 Nov. 1967
Stanley J. Townsend 24 Oct. 1968 38 p refs
(Grant NGR 52-026-012)
(NASA-CR-72477) Avail: CFSTI CSCL 20I

A large, inert gas, blowdown, magnetogasdynamic power generation facility was constructed to produce a large volume and mass flow rate of seeded argon or helium plasma and to dispose safely of the high temperature, corrosive plasma after testing. The facility is versatile enough to apply this plasma to a wide variety of channel geometries with minimal changes in reconfiguration. With the completion of the installation and satisfactory testing of all components but the seeding and seed-removal systems, an increased effort is being placed on analytical and diagnostic studies of the plasma. A series of calculations was performed for a uniform flow of current through an infinite, argon/NaK-90 plasma, when the driving electric field is U x B. A later study extended this to a solution of Laplace's equation in the channel where the boundary conditions are prescribed by a combination of electrodes, insulators and the free stream in the channel. Further modifications were introduced in this latter study to allow for strong gradients in electron temperature and pressure Author

N69-12577*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
TOPICS ON RANKINE CYCLE POWER SYSTEMS TECHNOLOGY
Martin J. Saari, Jack A. Heller, Robert G. Dorsch, Phillip L. Stone, Herbert G. Hurrell et al *In its* Selected Technol. for the Elec. Power Ind. 1968 p 35–89
Avail: CFSTI CSCL 18E

This article treats selected topics associated with that part of the Rankine power system that converts the thermal energy into the mechanical energy used to drive the electric generating equipment. The information has been obtained during efforts to develop power systems for space flight application. The space Rankine system is compared with ground-based power systems. Thermal design and stability of compact once-through boilers are discussed, including the double containment feature of the SNAP-8 boiler. The turbine blade erosion mechanism and the prediction of the erosion damage rate by analytical models are covered. Pump cavitation is discussed in terms of structural damage to the pump impeller, and pump technology and performance are reviewed. A brief material study compares the properties of a modified (Cr-1Mo steel with other alloys and stainless steels. The value of computer simulation for the analysis of system transient behavior is summarized. K.W.

N69-12578*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
BRAYTON CYCLE SYSTEMS
Warner L. Stewart, William A. Benser, Arthur J. Glassman, Donald C. Guentert, and Robert O. Hickel *In its* Selected Technol. for the Elec. Power Ind. 1968 p 91–137
Avail: CFSTI CSCL 10A

The principles of the gas turbine engine are reviewed, particularly the performance improvements made through use of the advanced technology generated in the propulsion field. Special features of the cycle as applied to airbreathing power systems as well as closed loops, where gases other than air can be used, are described. Efficiency, stage loading, high temperature operations, turbine materials, and fuels of open cycles are discussed. The discussion of the closed cycles covers the inert gas and carbon dioxide cycles, pressure losses, recuperation, and working fluids. K.W.

N69-12585*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
DIRECT ENERGY CONVERSION
Harvey J. Schwartz and James J. Ward *In its* Selected Technol. for the Elec. Power Ind. 1968 p 281–303

Avail: CFSTI CSCL 10B

Four types of direct-conversion processes are discussed: electrochemistry, thermoelectrics, thermionics, and magnetohydrodynamics (MHD). Of these processes, the potential usefulness of the space-power electrochemical storage battery to the electric power industry is pointed out. The technical or economic shortcomings of fuel cells, thermionics, and MHD in their present state of development are indicated. Costs and efficiency data for all systems are given. K.W.

N69-13045*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
RESULTS OF RESEARCH ON A SINGLE-COMPONENT SYSTEM FOR A LIQUID-METAL MHD CONVERTER
B. G. Bogomolv et al 1968 21 p refs Transl. into ENGLISH from Russian Conf. paper Presented at Symp. on the Production of Elec. Energy by Means of MHD-Generators, Warsaw, 24–30 Jul. 1968
(Contract NAS7-100)
(NASA-CR-97883; SM-107/135) Avail: CFSTI CSCL 10B
Problems in designing single-component closed loop MHD converter using potassium are discussed. The thermodynamic cycle is analyzed, and the two-phase nozzle design is discussed which is dependent on a semi-empirical method. Studies were made of the mixing chamber using a monojet and water, and observations were made by sampling the flow pressure and temperature, visually and with photographs and oscillographs. The effects of injection speed, vapor dryness, vapor temperature, and other parameters on operation of the MHD converter were investigated. The closed flow system is shown to be easily controlled and to be stabile, and the effect of the change in power fed to the steam generator on flow pattern is described. N.E.N.

N69-13069 Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
PLASMAS AND CONTROLLED NUCLEAR FUSION
In its Res. Lab. of Electron. 15 Oct. 1967 p 73–134 refs
(See N69-13060 03-34)
(Grant NSF GK-1165)
Avail: CFSTI
Research is reported on: (1) system C, (2) computer models of the beam-plasma interaction, (3) thin electron beam interactions with ions in a plasma-filled waveguide, (4) alternative stability analyses, (5) dynamics of the plasma boundary, (6) interactions of a spiraling electron beam with a plasma, (7) low-field microwave emission from contactless indium antimonide samples, (8) and hollow-cathode arc plasma. NSA

N69-13151*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
THERMODYNAMIC ANALYSIS OF NEW CYCLES FOR LIQUID-METAL MHD GENERATORS
V. M. Boldyrev et al 1968 11 p refs Transl. into ENGLISH from Russian Conf. Paper Presented at Symp. on the Productior of Elec. Energy by Means of MHD-Generators, Warsaw, 24–30 Jul 1968
(Contract NAS7-100)
(NASA-CR-97885; SM-107/142) Avail: CFSTI CSCL 10B
The problem of creating an acceleration device for an efficient liquid metal magnetohydrodynamic power plant is examined on the basis of separator and injector variants. Low internal efficiencies for the injector variant due to shock losses were analyzed, and literature advocating the use of a multistage injector cycle to eliminate the losses was reviewed. It is concluded that such a cycle will operate efficiently only after losses due to irreversible mixing of flows with substantially different temperatures are eliminated as well as those due to shock. Suggestions are made for the improvement of the thermodynamic multistage cycles with regeneration as related to three variants: a multistage separator plant with regenerative preheaters; a multistage injector plant with condensation of the vapor phase at optimum vapor and liquid velocities; and a multistage injector-separator plant using wet metal vapor. A.C.R.

N69-13240*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
THE EFFECTIVE ELECTRICAL CONDUCTIVITY OF A TWO-PHASE LIQUID-METAL FLOW
N. D. Gavrilova, L. D. Dodonov, and I. T. Aladyev 1968 6 p refs Transl. into ENGLISH from the Russian Conf. Paper Presented at the Symp. on the Production of Elec. Energy by Means of MHD-Generators, Warsaw, 24–30 Jul. 1968
(Contract NAS7-100)
(NASA-CR-97872; SM-107/153) Avail: CFSTI CSCL 10B
The hydrodynamics of a two phase vapor potassium flow for MHD generation of electric power are studied by comparing experimental results on two-phase flow conductivities. It is shown that the pondermotive forces in the two-phase flow, acting basically on the liquid metal, increase the slippage of the phases and the carrying away of the liquid from the boundary layer film to the vapor nucleus of the flow increases in the diffuse-annular structure; at the same time the conductivity of the flow decreases. G.G.

N69-13286*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
EXPERIMENTAL INVESTIGATION OF AN INJECTOR DEVICE
V. S. Danilian et al 1968 9 p refs Transl. into ENGLISH from Russian conf. paper Presented at Symp. on the Production of Elec. Energy by Means of MHD-Generators, Warsaw, 24–30 Jul. 1968
(Contract NAS7-100)
(NASA-CR-97878; SM-107/143) Avail: CFSTI CSCL 10B
The basic purpose of the work is to study the features of the characteristics (i.e. performance) of an injector using wet steam [vapor]. These investigations are of interest in connection with the fact that thermodynamic analysis shows that the optimum efficiency cycles of liquid-metal MHD plants [installations] must be accomplished on fairly wet steam. The operation of a wet steam injector along with the mixing chamber and diffuser [exit cone] includes the necessity of studying the operation of the steam [vapor] nozzle. This study is suitable both for conducting the study on a nozzle alone and on a nozzle coupled with the mixing chamber of the injector. Author

N69-13287*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
INVESTIGATION OF TWO-PHASE LAVAL NOZZLES
I. T. Alad'yev et al 1968 7 p refs Transl. into ENGLISH from Russian conf. paper Presented at Symp. on the Production of Elec. Energy by Means of MHD-Generators, Warsaw, 24–30 Jul. 1968
(Contract NAS7-100)
(NASA-CR-97877; SM-107/158) Avail: CFSTI CSCL 10B
A two-phase supersonic nozzle is an essential element of any liquid-metal MHD–generator scheme. At the present time there is no strict theory for such a nozzle, and existing methods for approximation calculations are based on many simplifications the validity of which are not at all clear. On the other hand, experimental investigations of two-phase nozzles are extremely limited and, in addition, contain information pertaining to a particular case. The accumulation of experimental data on two-phase nozzles, at the present stage, is an important problem. Some results of the experimental investigation of two-phase nozzles completed in a Heat Exchange Laboratory are presented. Author

N69-13288* Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
EXPERIMENTAL INVESTIGATIONS ON LIQUID–METAL MHD GENERATORS

G. A. Baranov et al 30 Jul. 1968 10 p refs Transl. into ENGLISH from Russian conf. paper Presented at Symp. on the Production of Elec. Energy by Menas of MHD-Generators, Warsaw, 24-30 Jul. 1968
(Contract NAS7-100)
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MHD generators due to the large velocities of the liquid-metal working medium have hydraulic losses in the ducts that comprise a considerable part in the total balance of power. The tendency has been noted to decrease the length of the operating ducts of the generators. However, end effects begin to appear associated with the openness of the magnetic system of linear generators, which leads to a sharp deterioration in their operating performance [characteristics]. A number of known methods of improving the performance of short generators are based on the equilization of the magnetic field in the gap along the duct and in the correct field shaping in the input and output zones of the working medium into the field. These questions were experimentally investigated on plane AC and DC linear generators. Work was performed in the selection of optimal duct geometry from the point of view of reducing their hydraulic resistance, and generators of the helical type were investigated where the end effects appear considerably weaker. Author

N69-13315# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
STUDIES OF ELECTRODES IN AN MHD GENERATOR [ISSLEDOVANIYE ELEKTRODOV V MHD GENERATORE]
V. C. Bznozovski et al *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 1-10 refs
(SM-74/62) Avail: CFSTI

Four different types of ceramic and metallic electrodes were studied in an MHD generator. Experiments were made on temperature of electrodes, their stability and erosion. Author

N69-13317# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
A METHOD OF OPTIMIZATION OF THE CONSTANT CURRENT ELECTROMAGNET IN AN MHD GENERATOR [METODIKA OPTIMIZATSII ELEKTROMAGNITA MGD GENERATORA POSTOYANNOGO TOKA]
Iosef Shenk *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 26-43 refs
(SM-74/83) Avail: CFSTI

The dependence of the specific computed costs and of the specific power of the electromagnet on the magnitudes of the magnetic induction $\beta(0)$ in the air gap and the current density σ in the windings for the optimum variants was studied. This dependence forms the basis for the optimization of the MHD generator and the MHD power station. From the point of view of economy the results obtained are favorable. They show that ferromagnetic electromagnets certainly have their place in MHD generators. However, it must be remembered that these results are relative if it is considered that the MHD method of energy conversion, at the present stage of development, has accomplished only the first step towards industrial utilization. Author

N69-13319# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
STUDY OF ELECTRODES MADE REFRACTORY METALS FOR MHD GENERATORS UTILIZING NONEQUILIBRIUM CONDUCTIVITY [ISSLEDOVANIYE ELEKTRODOV IZ TUGOPLAVKIKH METALLOV DLYA MGD GENERATOROV S NERAVESNOY PROVODIMOST'YU]
V. T. Karpukhin et al *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 60-68 refs
(SM-74/92) Avail: CFSTI

Results are described of experimental investigation of the emission characteristics of certain refractory metals and their alloys in a discharge, and of the investigation of the current distribution along the electrode suface and its dependence on the magnetic field. An estimate showed that for a current density of 1 to 5 amp/cm^2 in the channel of a Faraday type MHD generator with maximum segmentation of electrodes, the density of emission from separate electrode surfaces may increase to a few tenths amperes/cm^2. It is known that for generators utilizing nonequilibrium conductivity of the working substance, the requirement of uniformity of current in the generator volume is very important. All plasma inhomogeneities lower the output power of the generator. Therefore, uniform emission from the electrode surface is especially important. An analysis of the S-shaped emission curves of different refractory materials in the presence of cesium vapor, shows that at temperatures of the order of 1200 to 1500°K, thermionic current densities of a few tenths amperes/cm^2 are not possible. For this reason experiments were set up to determine the magnitude of the discharge current from the electrode surface as a function of the cathode material, its temperature, and the vapor pressure of cesium. The experiments were conducted on mercury-cesium and argon-cesium discharge. Author

N69-13324# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div
STUDY OF THE NONEQUILIBRIUM CONDUCTIVITY OF A PLASMA IN AN MHD GENERATOR [ISSLEDOVANIYE NERAVNVESNOY PROVODIMOSTI PLASMA V MAGNITOGAZODINAMICHESKOM GENERATOR]
M. I. Afanas'yev et al *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 113-119 refs
(SM-74/104) Avail: CFSTI

Under certain physical conditions the temperature of plasma electrons may be considerably higher than that of the ions and neutral particles. Such a state of thermodynamic nonequilibrium may be produced in the duct of an MHD generator by heating the electrons with the aid of an electric field induced by the plasma flowing transversly through a magnetic field. This leads to a considerable increase in the electrical conductivity of the plasma and in the power density of the MHD generator. Experiments were carried out on an MHD generator model. The inert gas was heated by means of dc plasmatrons. Measured amounts of an alkali metal were added in the liquid phase to the gas up to the point when the latter passed througn the arc discharge region. From the intermediate chamber the low-temperature plasma passed into the accelerating nozzle and then entered the linear MHD duct. Continuous and segmented electrodes were used in the MHD duct. The static pressure in the duct was 1 atm abs or higher. The velocity of the working fluid varied in both the subsonic and the supersonic regions. The gas temperature varied over a wide range. The different physical characteristics of the plasma were measured simultaneously by spectroscopic, aero-dynamic and electrical methods. Author

N69-13325# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
SOME RESULTS OF EXPERIMENTS WITH A 100-KW MH MHD GENERATOR MODEL [NEKOTORYYE REZUL'TATY EKSPERIMENTAL'NYKH ISSLEDOVANIY 100-KILOVATTNOY MODELI MGD GENERATORA]
M. S. Berger et al *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 120-131

(SM-74/212) Avail: CFSTI

Experiments were carried out with a model of a linear conduction MHD generator at fairly high levels of specific power, current density, and electric field strength. The MHD interaction was achieved in the fairly small model by raising the electrical conductivity of the working fluid by heating it to 3500 to 4500°K in an electric arc preheater. From the load characteristics the mean specific electrical conductivity of the gas under the experimental conditions were estimated: at the generator inlet—160 mho/m; at the generator outlet—75 mho/m. These values coincided with those computed for equilibrium conditions. Losses at the electrodes were 30 to 40 V in the initial sections of the model and 110 to 120 V in the final sections. The experiments did not reveal any fundamental limitations in the operation of the MHD generator on passing to higher specific parameters. Experimental conditions were achieved under which the MHD interaction in the generator duct became the determining factor, while end effects and phenomena occurring at the walls and at the electrodes were less important. Author

N69-13327# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ON THE EFFECTIVENESS OF ENRICHING AIR WITH OXYGEN IN INSTALLATIONS WITH MHD GENERATORS [OB EFFEKTIVNOSTI OBOGASHCHENIYA VOZDUKHA KISLORODOM V USTANOVKAKH S MGS GENERATORS]

G. I. Rossiyevskiy et al *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 142–154 refs

(SM-74/201) Avail: CFSTI

In open cycle MHD generators using ordinary air for the combustion of fuel, the increase in the initial parameters of the cycle (deceleration temperature of the combustion products before entering the channel t_{01}) is limited by the possibility of regenerative heating of the air by the combustion products. For natural gas the limiting value of t_{01} is about 2700° C with the necessary air preheating temperature of 2000° C. At the same time the construction of a high temperature combustion products-air heat exchanger presents one of the main difficulties in achieving installations with open cycle MHD generators. The use of oxygen enriched air in MHD equipment would permit the solution of two problems: first, equipment with a moderate temperature of oxidant preheating would be achieved, and second, the initial temperatures of the cycle would be higher than with the use of ordinary air. Author

N69-13329# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

THE EFFECT OF THE OUTPUT ON THE THERMAL EFFICIENCY IN ELECTRIC POWER STATIONS USING MHD GENERATORS [K VOPROSU O VLIYANII MOSHCHNOSTI ELEKTRICHESKIKH STANTSIY S MGD GENERATOROM NA IKH TEPLOVUYU EKONOMICHNOST]

G. I. Rossiyevskiy et al *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 162–173 ref

(SM-74/204) Avail: CFSTI

The basic thermal scheme of an electric power station is examined in which the air is heated by gases coming out of the MHD generator and the residual heat of the combustion products (after heating the air) is utilized in the vapor turbine part of the power station. The overall efficiency of the power station with an MHD generator is determined by the efficiency of the MHD generator cycle and the vapor turbine part of the installation, which depends on the choice of the initial parameters of the vapor. At present this choice is almost unique because of the minimum unit power of turbines. Higher initial parameters for the vapor turbines can be chosen only if their unit power is sufficiently high. Equipment with supercritical initial parameters of the vapor should be examined as possible replacements for vapor turbine power stations. Author

N69-13331# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

EXPERIMENTAL INVESTIGATION OF THE MAGNETOHYDRODYNAMIC GENERATOR [EKSPERIMENTAL'NOYE ISSLEDOVAANIYE MAGNITOGIDRODINAMICHESKOGO GENERATORA]

E. P. Strashnin et al *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 188–199 refs

(SM-74/206) Avail: CFSTI

Some results of investigations carried out in an experimental model of a linear MHD generator are discussed, on the combustion products of methane and oxygen seeded with an alkali metal salt. The MHD generator assembly consists of a combustion chamber, an operating channel, a magnetic system and associated equipment. The device is equipped with necessary measuring instruments. The combustion chamber is a cigar-shaped split structure with a detachable dispersal nozzle. The shape and dimensions of the nozzle vary, depending upon the particular problems to be investigated. A special feature of the combustion chamber is the jet ignition from a specially built-in diffusion burner, in which the gas and oxygen are tangentially fed from opposite directions. The ionizing impurity is introduced into the chamber by injecting an aqueous or alcoholic solution of an alkali metal salt. The combustion chamber is water-cooled and has an inner protective coating of fused magnesite. Liquid glass is used to provide the binding. The operating space of the combustion chamber is 8100 cm^3 and the maximum flow rate of the combustible mixture is 300 gm/sec. Author

N69-13332# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

EXPERIMENTAL INVESTIGATION OF VOLT-AMPERE CHARACTERISTICS OF A MAGNETOHYDRODYNAMIC CHANNEL WITH DIFFERENT ELECTRODES [EKSPERIMENTAL'NOYE ISSLEDOVANIYE VOLT-AMPERNYKH KHARAKTERISTIK MAGNITOGIDRODINAMICHESKOGO KANALA PRI RAZLICHNH ELEKTRODAKH]

E. P. Strashnin et al *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generations 14 Nov. 1968 p 200–209

(SM-74/209) Avail: CFSTI

The results are discussed of investigations of certain physical phenomena which occur in a channel operating on the combustion products of natural gas with oxygen at atmospheric pressure. The electrical conductivity of the plasma was sustained by ionizing additives which were introduced in the form of 20 to 40% solution of K_2CO_3 in water and KOH in alcohol. The experimental arrangement utilized a combustion chamber with flow rate of 200 gm/sec for the working mixture and with a matching nozzle which accelerated the plasma to a velocity of 500 to 600 m/sec. Different constructions of channels with ceramic lining were used. The voltage to the electrodes was supplied from a constant current generator. Author

N69-13333# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ELECTRICAL PARAMETERS OF A SYNCHRONOUS MAGNETOHYDRODYNAMIC GENERATOR WITH PULSATING ELECTRICAL CONDUCTIVITY OF MEDIUM [ELEKTRICHESKIYE PARAMETRY SINKHRONNOGO MGDG S PUL'SIRUYUSHEY ELEKTROPROVODNOST'YU SREDY]

L. G. Bezusyy *In its* Intern. Symp. on Production of Elec. Power by means of MHD Generators 14 Nov. 1968 p 210–220 refs

(SM-74/210) Avail: CFSTI

The initial model of the generator used is constructed on the basis of a number of simplifying assumptions relative to the nature of the flow, geometry of the channel, and electromagnetic properties of the materials involved. Unidimensional stationary flow of a noncompressible working fluid with a velocity v = |v; 0; 0| is assumed, directed along the axis of a rectangular channel of constant cross section. The channel has two conducting and two nonconducting walls. The nonconducting walls contact the surface of the poles of a dc electromagnet, creating a homogeneous excitation field across the channel. The potential difference across the conducting walls, depending on the design of the generator, is assumed equal to zero or a certain constant value; at first only the case of equal potentials corresponding either to a rectangular channel with short electrodes or to a coaxial channel which can be approximately replaced by a rectangular channel is analyzed. It is assumed that the magnetic ciruit is made of a nonelectrical conducting material with infinite magnetic permeability, while the materials of the nonconducting wall and the working medium have magnetic permeability. Author

N69-13335# Air Force Systems Command, Wright-Paterson AFB, Ohio. Foreign Technology Div.

THERMODYNAMICS OF A TWO-COMPONENT LIQUID METAL MHD POWER PLANT WITH AN INJECTOR [TERMODINAMIKA DVUKHKOMPONENTNOY ZHIDKO-METALLICHESKOY ENERGETICHESKOY MGD-USTANOV-KI S INZHEKTOROM]

K. A. Yakimovich et al *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 233–243 refs

(SM-74/218) Avail: CFSTI

Among the schemes of MHD power equipment with liquid metal as the working substance, one in which a vapor-liquid injector is used for converting the thermal energy of the vapor into the kinetic energy of the liquid, has aroused considerable interest. This interest has resulted from the simplicity of construction of the converter and from the absence of moving parts in it; used in conjunction with the MHD generator (and if necessary with the electromagnetic pump), this converter can make the power equipment completely static. This last fact is very significant if the equipment is intended for a transport system. The problems related to the evaluation of the efficiency of the thermodynamic cycle with an injector and also of the efficiency of the vapor-liquid injector proper, were examined in a series of articles. Author

N69-13336# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

CERTAIN PROBLEMS IN THE OPERATION OF A INSTALLATION WITH MHD GENERATOR [O NEKOTORYKH VOPROSAKH RABOTY USTANOVOKS MGD-GENERATO-ROM]

V. A. Kirillin et al *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 244–257 refs

(SM-74/221) Avail: CFSTI

The most important problem of present day power engineering is that of increasing the economy of thermal and atomic power plants. This problem acquires special significance in the regions where the cost of fuel is high. One of the most obvious ways to obtain a steep increase in the initial temperature (which determines the economy of the installation) of the working substance in the thermal power plants, is the use of the magnetohydrodynamic method of coverting thermal energy into electrical energy. This method is highly promising in many other cases also, for example in installations with minimum overall characteristics, in equipment with large power transient operation, etc. Specific points related to the problem of building power plants using MHD generators with open as well as closed cycles are examined. Author

N69-13339# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

PLASMA FLOW IN THE DUCT OF A "SERIES" MHD GENERATOR [O TECHENII PLAZMY V KANALA SERIYESNOGO MGD GENERATORA]

V. I. Kovbasyuk et al *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 272–279 refs

(SM-74/225) Avail: CFSTI

For Hall numbers comparable to unity, a series MHD generator has an advantage over Faraday, segmented, or Hall type MHD generators, since it admits of a high degree of electrode segmenting for a limiting number of different loads and gives a high conversion efficiency. The plasma flow in the generator duct has a number of special characteristics, determined by the changes in the physical properties of the working fluid along the duct and by changes in the local load factor for a given electrode configuration. A study is made of plasma movement in the duct of a series MHD generator. A general statement of the problem is formulated and conditions are determined for the validity of a quasi one dimensional flow model. Flow conditions close to the optimum are calculated and analyzed. Using a graphical analysis method a simple interpretation is given for the results obtained. Author

N69-13341# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

TRANSIENT PROCESSES IN SUPERCONDUCTING MAGNETIC SYSTEMS [PEREKHODNYYE PROTSESSY V SVERKHPROVODYASHCHIKH MAGNITNYKH SISTEMAKH]

V. V. Sychev et al *In its* Inter. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 288 301 refs

(SM-74/229) Avail: CFSTI

The possibility of using large superconducting magnets with rather high field intensities determines to a great extent the promise of effective usage of MHD installations in power engineering. In the creation of superconducting magnetic systems with tremendous working volumes, complex physical, technical, and engineering problems arise. The difficulties are not limited to the necessity of producing superconducting materials with high critical parameters. A number of extremely complex problems related to various areas of science and technology must be solved. In particular, one problem of prime importance is the investigation of the range of problems connected with the fundamental properties of the windings in a superconducting magnetic system as a physical object. Author

N69-13345# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

THERMODYNAMIC CHARACTERISTICS OF HIGH TEMPERATURE OPEN CYCLES [TERMODINAMICHESKIYE OSOBENNOSTI VYSOKOTEMPERATURNYKH OTKRYTYKH TSIKLOV]

G. M. Schegolev *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 328–337 refs

(SM-74/235) Avail: CFSTI

The high temperature open cycle, like the ordinary gas turbine cycle, can be represented on an entropy diagram. However, the extension of this cycle into a region of temperatures exceeding 2500°K creates some significant features in its operation. The

most important of these features are those related to the fact that the combustion products of the working substance undergo dissociation which can appear in the form of a significant increase in the specific heat. The specific heat of a dissociating gas can be considered as the sum of the ordinary specific heat and the specific heat induced by the effects of dissociative and recombination reactions. This specific heat is called the effective specific heat and like the degree of dissociation depends not only on the temperature, but also on the pressure. The examples presented show that purely thermodynamic analysis may prove to be a significant help in selecting the optimum cycle for a power plant using an MHD generator Author

N69-13346# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

AN EXPERIMENTAL INVESTIGATION OF THE ELECTRICAL CONDUCTIVITY OF PLASMA IN AN MHD GENERATOR MODEL [EKSPERIMENTAL'NOYE ISSLEDOVANIYE ELEKTROPROVODNOSTI PLAZMY NA MODELI MGDG]

N. M. Maslennikov et al *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 338–347 refs

(SM-74/236) Avail: CFSTI

At a gas temperature of 1300°K in the induced field, the experimentally measured electrical conductivity is 450 times greater than the equilibrium value of 0.068 mho/cm. Production of nonequilibrium electrical conductivity requires first of all that the proper density of the emission current from the cathode be provided in order to decrease the voltage drop in the layer around the cathode. Further increase in electrical conductivity is limited by the anode voltage drop. Higest possible increase in electrical conductivity requires that the optimum electrode length be selected. The relaxation of the electron temperature from the equilibrium value to the nonequilibrium value occurs over a short distance of the order of 0.3 cm. Author

N69-13347# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ELECTRICAL ARCS IN IONIZED AND NON-IONIZED GAS STREAMS [ELEKTRICHESKAYA DUGA V POTOKE IONIZOVANNOGO I NEIONIZOVANNOGO]

V. Yu. Baranov et al *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 348–359 refs

(SM-74/238) Avail: CFSTI

The experiments cited have shown that at small flow velocities the electric arc in the preionized gas can ensure sufficiently uniform ionization of the flow in the range of pressures which are of interest from the point of view of MHD generators. At velocities $\approx 10^5$ cm/sec an isolated transverse arc must burn in the breakdown regime and plasma from such a preionizer arrives in bunches. Although in principle conversion of electrical energy is possible with strongly modulated conductivity, this conversion is less efficient than in the case of uniform and sufficiently high conductivity. Author

N69-13348# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ON THE APPLICABILITY OF ELECTRODYNAMIC APPROXIMATION IN THE THEORY OF LIQUID METAL MHD ENERGY CONVERTERS [O PRIMENIMOSTI ELEKTRODINAMICHESKOGO PRIBLIZHENIYA V TEORII ZHIDKOMETALLICHESKIKH INDUKTSIONNYKH MGD-PREOBRAZOVATELEY ENERGII]

Ya. Ya. Liyelpeter *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 360–371 refs

(SM-74/240) Avail: CFSTI

In the theory of liquid metal MHD induction converters the process of energy conversion is described under the assumption of plane parallel flow of the liquid metal in the channel of the machine, i.e., the problem is treated in electrodynamic approximation. In this approximation the basic electromagnetic characteristics of the converter, the power transferred from the liquid metal to the stator or from the stator to the liquid metal, the power factor, the efficiency, and so on, can be obtained relatively simply. The results show that the main reason for the disagreement between the observed and computed values of the operating characteristics of MHD induction converters is the difference between the computed and actual values of the electromagnetic pressure and not the traveling field effect on the flow structure and the increase in the hydraulic loss. This conclusion is valid for converters with relatively long channels where reversible hydraulic processes along the channel length can be neglected. Author

N69-13350# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

THE PROBLEM OF DETERMINING THE DIMENSIONS OF AN MHD CHANNEL [K VOPROSU O DIMENZIONIROVANII MGD-KANALA]

I. D. Urusov *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 388–404 refs

(SM-74/242) Avail: CFSTI

Usually the first step in designing rotary electric machines is to solve the problem of dimensions, i.e., to make a choice about the main dimensions (diameter of the hollow portion, length of the active part of the machine). The final choice, subject to certain optimum conditions, enables one to carry out the subsequent detailed computations by a more precise definition of specific parameters and characteristics, necessary for working out the technical plan of the electrical equipment and its technical-economical indices. An analogous problem of determining the dimensions arises also in sketching the design of a power plant containing MHD generators. It is necessary to have preliminary reference data for these generators at the initial stage in order to do the subsequent planning and to be able to make the technical-economical comparison of the variants of the entire power complex. A change in the electrical conductivity of the working gas significantly affects the length and the volume of the channel. By using the power law dependence for the electrical conductivity of the working gas, it is possible to take into account the effects of the pressure. Author

N69-13352# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

SPATIAL EFFECTS IN MHD CHANNELS WITH SEGMENTED ELECTRODES [PROSTRANSTVENNYYE EFFEKTY V MGD-KANALE S SEKTSIONIROVANNYMI ELEKTRODAMI]

I. M. Tolmach *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 417–430 refs

(SM-74/248) Avail: CFSTI

The distribution of the current density along the electrode in an MHD channel with two electrodes was studied. For this purpose one of the end electrodes was divided into a number of segments separated by insulators. All the segments had the same potential and it was possible to measure the current flowing into each segment, by a loop oscillograph. The cross section of the channel was 15.9×15.9 mm^2, the length of the electrode, 50.8 mm; the current flowing into the entire electrode was 0.8 amp. The Hall parameter was equal to unity in all the modes. The spacing between the segments was 1.06 mm. The ratios of the measured current flowing into segments 1, 2, and 3 to the total current (0.8 amp) are designated by points for different modes of

operation of the channel. Since the current flows in all the segments, in all probability the process in the layer adjacent to the electrode did not involve arcing; this absence of arcing would bring the experimental condition close to the formulation of the theoretical problem. Author

N69-13391*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
INVESTIGATION OF A LIQUID-METAL JET MHD GENERATOR
K. I. Dmitriyev et al 1968 8 p refs Transl. into ENGLISH of a Russian paper presented at Symp. for the Generation of Elec. Power by Means of MHD Generators, Warsaw, 24–30 Jul. 1968
(Contract NAS1-100)
(NASA-CR-97864; SM-107/134) Avail: CFSTI CSCL 10B

The use of a free liquid-metal jet emitted from an accelerating nozzle with a velocity of ≈ 100–150 m/s for converting kinetic energy into electrical energy makes it possible to reduce several times over the friction losses in the generator and to eliminate completely the losses in the conducting walls of the duct However, the extraction of power from a free jet depends essentially on its stability in crossed magnetic and electric fields. The paper deals with an experimental study on the use of a free jet for MHD energy conversion. The results are given of experiments with a jet MHD generator employing a liquid-metal sodium circuit under different operating conditions (no-load, short-circuit, various loads). Author

N69-13670# Joint Publications Research Service, Washington D. C.
IONOSPHERIC MHD GENERATOR
P. Poletavkin 25 Nov. 1968 19 p Transl. into ENGLISH from Nauka i Zhizn' (Moscow), no. 9, 1968 p 34–40
(JPRS-46941) Avail: SOD/CFSTI

A method of producing electric power is proposed based on the use of solar radiation, thereby making it possible to maintain the equilibrium between the energy radiated by the earth and the energy received from the sun. The operating principles of a magnetohydrodynamic (MHD) generator are discussed to show that the occurrence of an electric current in ionospheric plasma is similar to the action of a MHD generator. Ways of utilizing this solar energy by means of an ionospheric MHD generator are assessed, and the view is offered that this generator is a natural electrical machine having a constant electrical current with a strength of about a million volts. M.G.J.

N69-13818*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
STUDY OF AN INDUCTION-TYPE LIQUID-METAL MHD GENERATOR
Yu. A. Bakanov et al 30 Jul. 1968 12 p refs Transl. into ENGLISH from Russian Conf. Paper Presented at Symp. on the Production of Elec. Energy by Means of MHD-Generators, Warsaw, 24–30 Jul. 1968
(Contract NAS7-100)
(NASA-CR-97876; SN-107/160) Avail: CFSTI CSCL 10B

Details are given on the construction and testing of a three-phase liquid potassium magnetohydrodynamic generator, which was developed to experimentally verify theoretical statements assumed in designing the generator. Using the optimized calculation, basic dimensions of the generator were selected, such as pole division, number of poles, active length, gap in the liquid metal, number of turns of the helical duct, and transverse internal cross section. The electrical circuit contained a three-phase battery of capacitors needed for self-excitation. The test circuit make it possible to investigate the generator in the parallel operating mode (connected parallel with the external mains), and in the autonomous self-oscillating mode. Equations are derived to determine the loses in the generator, and the results of measuring the separate components of these losses are examined. Also described are measurements of the magnetic field, and test data on self-excitation with power output which were obtained repeatedly for different values of capacitances, load, and temperature of the liquid potassium. M.G.J.

N69-14070*# Aztec School of Languages, Inc., Acton, Mass. Research Translation Div.
ELECTRICAL FIELD IN AN MGD-CHANNEL OF A RECTANGULAR SECTION WITH SEMITERMINAL ELECTRODES [ELEKTRICHESKOYE POLE V MGD-KANALE PRYAMOUGOL'NOGO SECHENIYA S POLUBESKONECH-NYMI ELEKTRODAMI]
M. M. Ignatenko Washington NASA Dec. 1968 8 p refs Transl. into ENGLISH from Magnitnaya Gidrodinamika, v. 4, no. 1, 1968 p 80–84
(Contract NASw-1692)
(NASA-TT-F-12010) Avail: CFSTI CSCL 20I

The electrical field is found in a magnetohydrodynamic channel of a rectangular section, two walls of which are semiterminal electrodes, and the other two of which are perpendicular to the direction of the external magnetic field and are insulators. The conducting fluid is assumed to be viscous and incompressible. The solution to the problem is obtained by the Wiener–Hopf method. Author

N69-14760*# McDonnell-Douglas Co., Huntington Beach, Calif. Western Div.
PARAMETRIC STUDY OF SPACE POWER SYSTEMS. VOLUME 2: TECHNICAL REPORT Final Report
A. D. Tonelli Nov. 1968 302 p refs
(Contract NAS2-4482)
(NASA-CR-73280; DAC-62304-Vol-2) Avail: CFSTI CSCL 22B

Presented are the results of the study effort on the Parametric Study of Space Power Systems. Included in the report is a description of the rationale used to select the power systems for investigation, a description of the guidelines and constraints used in the study, a description of the methodology used in the analysis of the power systems, and a review of complete power systems characteristics and sensitivity analysis. Also presented is a description of the H-521 computer program developed in the study, and a summary of power system technology readiness. Author

N69-15430# Academy of Sciences (USSR), Moscow.
Hg AND Cs AS WORKING MEDIA FOR STUDIES OF CERTAIN PROPERTIES OF MHD GENERATORS WORKING IN A RANKINE CYCLE
Ya. A. Kereev, V. T. Karpukhin, and A. V. Nedospasov 1967 13 p refs Presented at the Symp. on Magnetohydrodyn. Elec. Power Generation, Warsaw, 24–30 Jul. 1968
(SM-107/130; CONF-680704 3) Avail: CFSTI

The results of the experimental and theoretical investigations aimed at the characteristics of the Hg–Cs plasma in crossed electrical and magnetical fields are described. Calculations are shown for MHD generators with the real (turbulent) conductivity in nonequilibrium plasma, and estimations of achievable efficiency and the degree of efficiency of the plant working with these media are made. Author (NSA)

N69-16485*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
RESEARCH AND ADVANCED CONCEPTS
In its Supporting Res. and Advanced Develop. 31 Oct. 1968 p 120–132 refs
Avail: CFSTI CSCL 21H

Hollow cathode operation in the SE-20C mercury ion thruster continued, with emphasis placed on tests using an adjustable cathode pole piece and baffle assembly. The results indicate that introducing all or a large fraction of the propellant through the cathode may limit utilization and increase discharge losses. Since thruster efficiency depends directly on the characteristics of the discharge plasma a study, using the Langmuir probe, was made to evaluate the efficiency improvements, and the influence of the operating parameters. Figures depict the preliminary results. Investigations continued on the use of liquid-metal magnetohydrodynamic power conversion as a power source for nuclear electric propulsion. Generator test data are given. Further investigations were conducted on flow visualization as related to the effects of a transverse gas velocity on a glow discharge; the potential distribution within the electrical discharge region was obtained by a probe. It was found that severe distortions of the potential distribution and current distribution, caused by a transverse flow field, introduce significant complexity into theoretical approaches for computing heat transfer to the electrodes. M.G.J.

N69-18068*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
POWER SYSTEMS RESEARCH AT MSFC
Richard Acker, Richard J. Boehme, William L. Crabtree, Walter H. Goodhue, Charles B. Graff et al *In its* Res. Achievements Rev., Vol. 2 1968 68 p
Avail: CFSTI CSCL 10

A scale model was developed of a 6 V, 70 A-hr battery containing cells with the exact electrode configuration and size that will be required for the 28 V, 400 A-hr vehicle power system. A capillary matrix close-loop cell system was developed for space applications. Basic development work resulted in the fabrication of a design verification test fuel cell system for qualification on space missions. Fuel cell technology research was conducted in electrodes and electrolytes at the basic research level and in cooling systems and environmental testing at the systems' analysis level. A systems analysis and description are presented on the SNAP 29 power system. A method for predicting the amount of power available from a solar array in circular orbit and under gravity gradient stabilization is presented. A brief presentation is made of the metal arc illuminator for solar array testing. An electrical power conversion system designed for a manned earth orbital vehicle is described. A comparison is made of several typical motors used to power auxiliary equipment up to 1.5 kW; the advantages and disadvantages of each type motor are mentioned. B.P.

N69-18439# Advisory Group for Aerospace Research and Development, Paris (France).
SELECTED TOPICS IN ELECTROFLUID DYNAMIC ENERGY CONVERSION
Maurice O. Lawson ed., and Frank Wattendorf, ed. Dec. 1968 260 p refs Presented at Electrofluid Dyn. Workshop Conf., Wright-Patterson AFB, Ohio, 23–25 May 1966 Supported in part by ARL
(AGARDOGRAPH-122) Avail: CFSTI

CONTENTS:

N69-18440# Aerospace Research Labs., Wright-Patterson AFB, Ohio.
THE ROLE OF ELECTROFLUID DYNAMICS IN THE FIELD OF DIRECT ENERGY CONVERSION
Hans von Ohain *In* AGARD Selected topics in Electrofluid Dyn. Energy Conversion Dec. 1968 p 5–13
Avail: CFSTI

Although relatively unexplored among the many direct energy conversion processes, electrofluid dynamics (EFD) promises performance characteristics complementary to other processes in the overall energy conversion spectrum. The high potential, low current density electrical power of EFD devices has several natural applications. Moreover, virtually unlimited application possibilities will open up with the development of compact, inexpensive power conditioning apparatus. Author

N69-18441# Aerospace Research Labs., Wright-Patterson AFB, Ohio.
ELECTROFLUID DYNAMIC ENERGY CONVERSION PROCESSES CHARACTERISTICS AND RESEARCH AREAS
Maurice O. Lawson *In* AGARD Selected topics in Electrofluid Dyn. Energy Conversion Dec. 1968 p 14–33 refs

Avail: CFSTI

The major characteristics of electrofluid dynamic generators are quite different from other direct energy conversion generators so that an important class of generators complementary to other generators is promised. Theoretical analyses have indicated the basic relationships between the various aerodynamic and electrical parameters. First order types of analyses have been made for different types of geometries, including the axisymmetric and two

dimensional. More exact analyses remain to be done and experimental research efforts are in a rather early state. The experimental data obtained so far established reasonably good faith in the theoretically predicted trends and relationships. Much of this experimental effort has been concentrated in unipolar charge production, as the achievement of proper current levels is a prerequisite for a favorably operating generator. Other major research areas are electrode and channel geometries, high voltage and high voltage gradient insulation, properties of working fluids and suitable overall cycles for converting heat efficiently into electrical energy. Author

N69-18442# Aerospace Research Labs., Wright-Patterson AFB, Ohio.

EFFECTS ON ELECTRODE GEOMETRY SIMILARITY AND SCALING LAWS IN EFD ENERGY CONVERSION PROCESSES. PART 1: FUNDAMENTAL CONSIDERATIONS

John A. Decaire *In* AGARD Selected topics in Electrofluid Dyn. Energy Conversion Dec. 1968 p 34–63 refs

Avail: CFSTI

Attractive performance characteristics are possible with viscous EFD processes which employ electrode and channel configurations corresponding to small aerodynamic drag losses, and which utilize pressurized gases of low molecular weight and high dielectric strength containing unipolar charged particles. Basically however, EFD processes are low pressure ratio processes inconsistent with a high overall conversion efficiency from heat into electricity. To overcome this incompatibility, ARL is exploring a special two-loop, two-fluid cycle. Successful operation of this concept requires the ability to seed the working medium with charge densities which are the highest possible consistent with fundamental channel limitations. A corona discharge is being investigated for charge seeding. Author

N69-18444# Aerospace Research Labs., Wright-Patterson AFB, Ohio.

WORKING MEDIA FOR ELECTROFLUID DYNAMIC GENERATORS

Michael Hawes *In* AGARD Selected topics in Electrofluid Dyn. Energy Conversion Dec. 1968 p 96–123 refs

Avail: CFSTI

Desirable characteristics of electrofluid dynamic working media with regard to power generation are reviewed. The dimensionless numbers of interest for power density and stage efficiency are cited. Since special mixtures of gases can provide better values of these dimensionless numbers than a single gas or vapor, an experimental program to determine dielectric strength of gas mixtures was conducted. Investigation results are given and comparisons with high pressure air as the working medium are made. Author

N69-18445# Aerospace Research Labs., Wright-Patterson AFB, Ohio.

SOME ANALYTICAL TREATMENTS OF EFD PROCESSES

John E. Minardi *In* AGARD Selected Topics in Electrofluid Dyn. Energy Conversion Dec. 1968 p 124–179 refs

Avail: CFSTI

An approximate, analytic solution to the charge cloud growth in an axisymmetric electrofluid dynamic (EFD) generator is presented. With these formulas, a computer program is used to calculate the efficiency and power density over a wide range of parameters. A computer program for plane parallel electrodes that includes the effects of charge spreading due to the electric field is also developed. Results show that electric field effects on the motion of charged colloids are negligible. Therefore, a numerical approach is developed to study complex electrode geometries of EFD generators considering the charge distribution to be known from fluid flow considerations. Author

N69-18446# Von Kaman Inst. for Fluid Dynamics, Rhode Saint-Genese (Belgium).

SOME REMARKS ON EFD ENERGY CONVERSION

Jean-Pierre Contzen *In* AGARD Selected Topics in Electrofluid Dyn. Energy Conversion Dec. 1968 p 180 186 refs

Avail: CFSTI

Some of the work carried out in Belgium in the field of fluid dynamics associated with electric or magnetic effects is briefly reviewed. The paper gives also some suggestions on possible applications of the EFD energy conversion process. Author

N69-18447*# Toronto Univ. (Ontario). Inst. for Aerospace Studies.

DESIGN AND CONSTRUCTION OF A 3-MW MAGNETOGASDYNAMIC POWER GENERATION FACILITY AT THE UNIVERSITY OF TORONTO INSTITUTE OF AEROSPACE STUDIES

Stanley J. Townsend *In* AGARD Selected Topics in Electrofluid Dyn. Energy Conversion Dec. 1968 p 188 202 Supported in part by NASA, Defence Res. Board, and Ontario Dept. of Univ. Affairs

Avail: CFSTI CSCL 20I

The design features of a 3-MW, blow-down plasma facility are described. The primary aim has been to construct a facility having a large interaction channel to emphasize volume rather than surface effects. Independent control of flow velocity, static pressure, static gas temperature and magnetic field in the channel can be achieved over a wide range of operating conditions. Static pressures are achievable from a few Torr to over seven atmospheres, stagnation temperatures up to 2200–2500°K and magnetic fields up to 1.7 Tesla. Provision has been made for the additional radial or vortex-flow channels on a separate outlet of the main heater at a later date. Instrumentation of a constant-area channel, 5 cm × 10 cm × 120 cm, to measure the voltage and current characteristics of up to fifty electrode pairs has been completed. First runs are expected in the summer of 1968. Author

N69-18448# Technical Univ., Copenhagen (Denmark). Fluid Mechanics Dept.

PLASMA RESEARCH IN DENMARK

K Refslund *In* AGARD Selected Topics in Electrofluid Dyn. Energy Conversion Dec. 1968 p 203–204

Avail: CFSTI

Advanced plasma research in Denmark concentrated on the following three pieces of equipment: (1) a Q-machine for studying wave instabilities in plasmas. The parameters are measured in by Langmuir probes; (2) the a spark-shorting capacitor band over two, parallel slabs of brass placed in vacuum for plasma production. Observations are made by smear camera and by mass spectrometer on the following: N_2, Ne, Ar, and He; and (3) a homopolar machine with a fast acting gas valve for studying rotating high energy plasmas. G.G.

N69-18450# Deutsche Versuchsanstalt fur Luft- und Raumfahrt, Stuttgart (West Germany). Institut fuer Energiewandlung und Elektrische Antriebe.

THE ELECTROFLUID DYNAMIC ENERGY CONVERTER WITH SPACECHARGE NEUTRALIZATION

Eugen Knoernschild and Peter A. Schoeck *In* AGARD Selected topics in Electrofluid Dyn. Energy Conversion Dec. 1968 p 210-232
Avail: CFSTI

This paper is concerned with a device which would eliminate the biggest disadvantage of the electrofluid dynamic (EFD) converter, namely its operation at very high voltage. The question, in which the first-named author was interested about ten years age, was whether one could get rid of the space charge and design a converter which has its space charge neutralized, and therefore would operate at any voltage desired. In recent years this idea was taken up in the Hall accelerator which can be considered a space charge neutralized ion engine. After a short introduction to the various types of EFD energy converters, the basic difference between the space charge limited and the space charge neutralized operation is pointed out. The importance of a magnetic field on the mechanism of space charge neutralization is described. The equation of flow and of the forces which act in a space charge neutralized converter are derived. Test results which prove that space charge neutralization is possible, are presented. Author

N69-20548# National Academy of Sciences—National Research Council, Washington, D. C. ommittee on Undersea Warfare.
ENERGY SYSTEMS OF EXTENDED ENDURANCE IN 1-100 KILOWATT RANGE FOR UNDERSEA APPLICATIONS
Sep. 1968 133 p refs
(Contract Nonr-2300(08))
(AD-681068; NRC-CUW-0348; PUBL-1702) Avail: CFSTI CSCL 10/2

A report is given on the state of technology of energy systems that may have undersea applications by a select panel. The pertinent features of the most promising among electrochemical and nuclear sources, as well as dynamic conversion and cable transmission systems are discussed in some detail. Related technologies such as hydrogen-oxygen supply systems and heat transfer technology are also summarized. The nature, magnitude and priority of effort required for the Navy to have available several alternatives for meeting its future needs is also detailed. Author (TAB)

N69-20852*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
COMPARISON OF BRAYTON AND RANKINE CYCLE MAGNETOGASDYNAMIC SPACE-POWER GENERATION SYSTEMS
Lester D. Nichols Washington Mar. 1969 59 p refs
(NASA-TN-D-5085) Avail: CFSTI CSCL 10B

Idealized Brayton- and Rankine-MHD cycles are considered for use in space. The Brayton-MHD cycle uses neon as the working fluid; the Rankine-MHD uses lithium. Both are seeded with cesium. The systems are restricted to a specified generator length and specific radiator area. It is shown that generally an entrance Mach number of 1.0 provides maximum power output; for the same value of Hall parameter the Rankine-MHD system may be used at a lower temperature than the Brayton-MHD; but at the same maximum temperature the Brayton-MHD generates more power than the Rankine-MHD. Subsonic entrance Mach number is recommended for Brayton-MHD, and supersonic for Rankine-MHD. Author

N69-20875*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
ELECTROTHERMAL INSTABILITIES IN THE ENTRANCE REGION OF AN MHD GENERATOR
J. Marlin Smith Washington Mar. 1969 23 p refs
(NASA-TM-X-1761) Avail: CFSTI CSCL 20I

In the entrance region of a nonequilibrium MHD generator one finds an abrupt rise in electron temperature followed by a four- or five-decade increase in electron density. We consider the stability of this region of abrupt electron density rise. A solution is found in the limit that the ambipolar diffusion field is small compared to the transverse applied electric field. The solution is found to be stable in the limit of zero magnetic field but to be unstable in the presence of a magnetic field. Author

N69-21275# Avco-Everett Research Lab., Everett, Mass.
INSTABILITY OF HALL MHD GENERATORS TO MAGNETO-ACOUSTIC WAVES
Frank J. Fishman Feb. 1969 42 p refs
(RR-323) Avail: Issuing Activity

It is known that magnetoacoustic waves propagating anti-parallel to a steady electric current in a dense, weakly ionized gas may exhibit substantial growth. The stability of a Hall MHD generator with supersonic flow to disturbances of this type is assessed. A proper boundary value problem is solved, with full consideration of the load circuit, which may serve as a feedback path for wave energy. It is shown that this feedback may lead to instabilities even under conditions such that the wave growth (as evaluated by earlier investigations) is slow. Disturbances with a period comparable to the flow time (channel length/fluid velocity) are the principal contributors to the instability; the spatial variation of these disturbances are far from sinusoidal. The control of machine instabilities by electrical filters in the external (load) circuit is described. Author

N69-21373# Aktiebolaget Atomenergi, Stockholm (Sweden).
NONLINEAR DYNAMIC MODEL OF POWER PLANTS WITH SINGLE-PHASE COOLANT REACTORS
Heinz Vollmer Dec. 1968 34 p refs
(AE-341) Avail: CFSTI

The traditional way of developing dynamic models for a specific nuclear power plant and for specific purpose seems rather uneconomical, as much of the information often cannot be utilized if the plant design or the required accuracy of the calculation is desired to be changed. It is therefore suggested that the model development may be made more systematic, general and flexible by: applying the 'box of bricks' system, where the main components of a nuclear power plant are treated separately and combined afterwards according to a given flow scheme, a dynamic determination of the components which is as general as possible without taking into account those details which have a minor influence on the overall dynamics; providing approximations of the more rigorous solution sufficient to meet the user's requirements

N69-21376*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
ANALYSIS OF A MULTISTAGE LIQUID METAL MAGNETOHYDRODYNAMIC POWER CONVERSION CYCLE
L. G. Hays 1 Apr. 1969 12 p refs
(Contract NAS7-100)
(NASA-CR-100500; JPL-TR-32-1371) Copyright. Avail: CFSTI CSCL 10B

A liquid metal magnetohydrodynamic (MHD) power system with power extraction at several stages in the expansion process is discussed and analyzed. Cycle efficiency is shown to improve from the 6% range for a single stage 1800°F system to the 10% range for multistage 1800°F systems. Cycle efficiency at 2000°F is slightly lower but a smaller radiator area is attainable than at 1800°F. The advantages of lower liquid metal velocities and MHD generator redundancy are also possible in a multistage system. Author

N69-21929*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
MAGNETOHYDRODYNAMIC INDUCTION MACHINE
David G. Elliott, inventor (to NASA) Issued 14 Jan. 1969 (Filed 6 Jul. 1966) 10 p Cl. 310–11
(NASA-Case-XNP-07481; US-Patent-3,422,291; US-Patent-Appl-SN-563650) Avail: US Patent Office

An MHD induction machine was designed in which the MHD induction phenomenon is more closely analogous to that taking place in a conventional rotating induction machine. This was done in order to increase the efficiency of the MHD induction machine to the level attained with rotating machines By providing end poles which produce a compensating magnetic field, the flux through the conducting fluid in the MHD induction machine is constant at zero slip, minimizing the induction of heating currents therein. The net magnetic field which the fluid traverses is analogous

N69-22640# California Univ., Livermore. Lawrence Radiation Lab.
LARGE SUPERCONDUCTING BASEBALL MAGNET, PART 1
C. D. Henning, R. L. Nelson, M. O. Calderon, A. K. Chargin, and A. R. Harvey 21 Mar. 1968 21 p refs Submitted for publication
(Contract W-7405-eng-48)
(UCRL-71010; Conf-680813-3) Avail: CFSTI

A 1.2-m-diam superconducting magnet is under construction as part of the Alice experiment in controlled thermonuclear fusion research. Shaped like the seam of a baseball, the magnet will produce a cusped magnetic field, close to 20 kG in the center, and up to 75 kG at the conductor. The superconductor, a 1/4-in.-square composite of niobium–titanium with copper, will carry 2400 amperes during partially stable operation. Previously, large magnets have been conservatively designed for total nucleate-cooling stability. However, in this instance, space limitations have demanded a more severe stability requirement. Other novel features of this magnet include the ability to vary the shape of the magnetic field and the use of a new high-manganese stainless steel for the force restraining structure. Author (NSA)

N69-23173# California Univ., Livermore. Lawrence Radiation Lab. Radiation Lab.
RANKINE CYCLE SYSTEMS STUDIES FOR NUCLEAR SPACE POWER
J. H. Pitts and M. H. L. Jester 31 May 1968 24 p refs
Submitted for publication Supported by AEC
(UCRL-70863; Conf-680802-6) Avail: CFSTI

Two different types of Rankine cycle systems studies are described which can be used to advantage in conjunction with each other. A simple, flexible conceptual design representation gives consistent, general trend results and yet requires minimum expenditure of effort to incorporate changes. After initial design phases are complete, a detailed system representation that includes extensive neutronic and shielding information is used to give final design characteristics of the complete system and components of interest. Some recommendations for future effort are made. Author (NSA)

N69-23954# Princeton Univ., N. J. Plasma Physics Lab.
A CURSORY LOOK AT TOKAMAK FUSION REACTORS
R. G. Mills Dec. 1968 15 p refs
(Contract AT(30-1)-1238)
(MATT-659) Avail: CFSTI

Hypothetical fusion reactors of the Tokamak and stellarator types are extremely similar. The similarities include the following five points: (1) A toroidal vacuum chamber is required, of low aspect ratio. (2) A divertor is needed. (3) A cold fuel injection system is assumed. (4) Auxiliary plasma heating apparatus is required for ignition. (5) they must operate at a particular value of the product of ion density and confinement time. The differences are: (1) The induced plasma current in a Tokamak supplants the use of helical windings in the stellarator (2) Cyclic operation is necessary for Tokamaks (3) Tokamaks may require a lower β than stellarators. Difference number one could be an important advantage for Tokamaks, while difference number two may be only a small disadvantage since the duty cycle should be high. Difference three may be important. Author (NSA)

N69-23996# Bell Helicopter Co., Fort Worth, Tex.
THE EFFECT OF ADVANCED PROPULSION ON FUTURE ROTARY WING TYPE AIRCRAFT
L. M. Graham, A. W. Shultz, and H. C. Smyth *In* AGARD Helicopter Propulsion Systems Jun. 1968 16 p ref

Avail: CFSTI

Three types of rotary-wing aircraft were studied: a pure helicopter, a slowed-rotor compound helicopter, and a tilting-proprotor composite aircraft. Using the gas generator turbine-inlet temperature as an index, the general trends of improvement in specific fuel consumption, specific weight, specific fuel consumption at part power, and available power at high ambient temperatures were determined. These trends were then used to forecast the characteristics of rotary wing aircraft designed to hover at 4000-foot pressure altitude, at 95°F, with a payload and crew of 4000 pounds, and having design ranges of 200 and 400 nautical miles. It was concluded that for the same payload, performance, and mission, the aircraft using advanced technology engines will be much smaller and lighter than those using current generation engines. The fuel required and the installed power necessary to perform a given mission will be reduced with the advanced technology engines. These improvements will substantially increase the productivity and the cost effectiveness of the aircraft. The degree of improvement will vary almost directly with the design range. Author

N69-23998# Pisa Univ. (Italy).
SIMPLE SOLUTIONS OF THE HELICOPTER PROPULSION SYSTEM MADE POSSIBLE USING CLOSED CYCLE FOR THE WORKING FLUID
Dino Dini *In* AGARD Helicopter Propulsion Systems Jun. 1968 34 p refs
Avail: CFSTI

Several configurations for small helicopters operating in the 50 to 200 HP range of useful power are analyzed showing suitable rotor-engine integration using a light-weight closed cycle steam engine. It is demonstrated that a multiple expansion engine can turn directly without gearing the utilization shaft, thus reducing the total working fluid weight to an acceptable level. Real cycles, mechanical designs, with convenient economic, volume and weight characteristics, are discussed. The possible use of simple closed cycle engines, operating at different speeds and altitudes, with fluidic controls is also treated. Particular advantages are emphasized as a first step toward future applications at such time when compact heat sources, such as the Velox boiler, radioisotopes and nuclear reactors, become available for this purpose. A.C.R.

N69-24985# Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires.
ALL-METAL THERMIONIC NUCLEAR MODULE [MODULE THERMOIONIQUE NUCLEAIRE TOUT-METAL]
B. Devin, J. P. Durand, and P. Ragot [1968] 8 p In FRENCH Presented at the Intern. Conf. on Thermionic Elec. Power Generation, Stresa, Italy, 27–31 May 1968

(CEA-CONF-1041; CONF-680508-9) Avail: AEC Depository Libraries

This all-metal thermionic module is distinguished from a normal cylindrical diode by the collector ensemble. The Mo collector is covered by a layer of alumina, placed inside a tube of Ti–Al and the two are compacted together by hot isostatic compression. The base of the collector structure has a cavity for the integrated cesium reservoir. The reservoir is charged separately with cesium-impregnated graphite. The optimum dimensions of the module were calculated. Experimental results on the performance of the all-metal thermionic module are tabulated. The lower yield in comparison with conventional converters is compensated by the simplicity of fabrication from commercial components, the sturdiness, and the cost. NSA

N69-25396*# Pennsylvania Univ., Philadelphia. Electrochemistry Lab.

STUDIES IN FUNDAMENTAL CHEMISTRY OF FUEL CELL REACTIONS Semiannual Progress Report, 1 Jan.–30 Jun. 1968

John O'M. Bockris Jun. 1968 44 p refs
(Grant NGR-39-010-002)
(NASA-CR-100892; SAPR-12) Avail: CFSTI CSCL 07D

Ellipsometer data on phase changes and changes in the amplitude ratio of polarized light reflected from an adsorbed anion layer on a mercury surface were analyzed and compared wit data obtained by electrocapillary methods. A good agreement was found between both methods. The development of alkali metal-air batteries progressed with the design of computer programs for calculating the three dimensional path of minimum potential energy and the potential energy profile along this path for ions moving through the crystal lattice. The dendritic deposition of zinc from alkaline solution was studied by measuring the changes in double layer capacitance as zinc deposition proceeded both above and below the critical initiation overpotential. A qualitative model of dendrite initiation based on progressive surface roughening was formed. G.G.

N69-25803# Institute for Defense Analyses, Arlington, Va. Science and Technology Div.

PERFORMANCE, ANALYSIS SELECTION OF BALLOON ELECTRICAL POWER SYSTEMS

Robert C. Hamilton Dec. 1968 82 p refs
(Contract DAHC15-67-C-0011)
(AD-682898; P-455) Avail: CFSTI CSCL 10/2

The weights of selected 200- and 4000-watt power systems for tethered and free balloons are presented as a function of operating time at altitudes of 10,000, 20,000, 30,000, and 50,000 ft. For tethered balloons, the 8-kv cable system weighs less than any other system that could be made available within 18 months. The microwave rectenna systems, when developed, would weigh appreciably less than the high-voltage cable system at 200 watts. The margin of performance of the 4-kw microwave rectenna system over the high-voltage cable system should be significant, particularly at 30,000- and 50,000-ft altitudes. For free balloons, which cannot use the preferred tethered cable or microwave rectenna systems, the minimum weight power system is the hydrogen-oxygen fuel cell for operating times of 50 hours or less. The solar-cell/fuel-cell combination is superior for operating times of 50 hours or more at the 4-kw level and 120 hours or more at the 200-watt level. Author (TAB)

N69-26189# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

A COMPARISON OF MAGNETIC SYSTEMS FOR PRODUCING STRONG LARGE-VOLUME FIELDS

Ye. L. Zaremba et al 31 Oct. 1968 24 p refs Transl. into ENGLISH from Magnitn. Gidrodinam., Akad. Nauk Latv. SSR (Riga), no. 4, 1967 p 124–134
(AD-683989; FTD-MT-24-375-68) Avail: CFSTI CSCL 10/2

Four types of magnetic systems are analyzed and compared with regard to their suitability for use in large-scale MHD power generators. The four types discussed are: (1) an ironless coaxial magnetic system with a tangential field, (2) an ironless elliptical-type system with a winding in the form of two intersecting ellipses or circles, (3) an O-shaped system with a magnetic circuit, and (4) a diamond-shaped system with a magnetic circuit. The tabular data show the advantages of the elliptical system over the others for the whole range of the excitation energy, which is a function of the relative thickness of the current layer. The diamond-shaped system is preferred, however, if losses can be reduced by reducing the resistivity of the winding material. In the magnetic systems analyzed, excitation losses amount to about 10% of the generated energy, provided the MHD generator is sufficiently large. TAB

N69-26241# Joint Publications Research Service, Washington, D.C.

SOVIET STUDIES ON MAGNETOHYDRODYNAMIC GENERATORS

A. T. Rakhimov et al 14 May 1969 41 p refs Transl. of the book "Electricity from MHD, Vol. 1" 1966 p 333–341; p 465-472
(JPRS-48041) Avail: CFSTI

CONTENTS:

N69-26242# Joint Publications Research Service, Washington, D.C.

MAGNETIC HYDRODYNAMICS OF FLOW IN MHD DUCTS

A. T. Rakhimov et al *In its* Soviet Studies on Magnetohydrodynamic Generators 14 May 1969 p 1–11 refs

Avail: CFSTI

Problems are discussed of the magnetic hydrodynamics of flows with hot electrons in MHD ducts at low magnetic Reynolds numbers. In connection with boundary layer theory, conditions of the occurrence of detachment and the jump in density associated with it are discussed for a supersonic flow. Methods of preventing detachment are discussed: in particular the required degree of exhaustion of the plasma from the boundary layer is calculated. Attention is also given to wave resistance to a supersonic flow which arises from the uneven distribution of the current on the electrode wall of the duct. In connection with the theory of shock waves in a plasma with hot electrons, the structure of these waves in relation to ionization is considered, together with their stability. Problems related to the appearance of parasitic closed currents, with a strong reduction in conductivity of the plasma beyond the shock-wave front and a change in the mode to accelerating, are also dealt with. Author

N69-26243# Joint Publications Research Service, Washington, D.C.

CALCULATION OF THE BOUNDARY LAYER AT THE ELECTRODE OF A PLANE MHD GENERATOR

A. Ye. Yakubenko *In its* Soviet Studies on Magnetohydrodynamic Generators 14 May 1969 p 12–21 refs

Avail: CFSTI

The problem of the flow of an electrically conducting gas through crossed electric and magnetic fields in a plane MHD generator with ideally conducting walls is considered. The conditions are set forth for independently solving problems relating to the boundary layer at the electrodes and to the center of the flow. The conditions at the center of the flow are calculated numerically by means of one dimensional theory for subsonic and supersonic velocities. The dependences of the flow characteristics on the load parameter are found. The nonautomodel boundary layer equations are solved numerically for small magnetic Reynolds numbers at one of the MHD generator electrodes. The dependence of the resistive force and the Nusselt number on the load parameter and the coordinate along the electrode is found. It is shown that the resistive force and the heat flux described by the Nusselt number increase considerably as compared to the case of nonconducting gas.
Author

N69-26520# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
SECOND GENERATION GAS TURBINE ENGINES. DISCUSSION OF TURBOFAN ENGINES
Hsiao Ling 23 Aug. 1968 11 p refs Transl. of Hang K'ung Chih Shih (Mainland China), v. 1, no. 10, 1964 p 16–18
(AD-683118; FTD-HT-23-858-67) Avail: CFSTI CSCL 21/5

Turbojet aircraft fly at a speed exceeding 2000 km/hr and have a higher rate of fuel consumption. Mig-15 and Tu-104 aircraft powered by turbojet engines have a fuel consumption rate of 0.8-1.0 kg per 1-kg thrust per hr. Turboprop engines were developed for the purpose of fuel economy. Turboprop engines have similar construction and operate on the same principle as a turbojet engine. The only difference in a turboprop engine is the addition of a propeller outside the compressor. Turboprop engines are built for long-range civil transport airplanes flying at a speed of 800-900 km/hr. Turboprop engines can also be used in military aircraft having a flying speed of 4-4.5 mach if an afterburner is added. Tests showed that the fuel consumption of turboprop engines is reduced 16-20% under the same internal flow condition. Takeoff thrust is also increased 30-40% and engine noise is reduced 10-15 db. Turboprop engines, however, are more complicated in construction, heavier, and larger in diameter (30-40%) than turbojet engines. More than 40 types of turboprop engines have been developed recently. A small turboprop engine capable of producing a thrust of only 300 kg is in process of development. A large turboprop engine having a thrust of 9000-10000 kg and a fuel consumption rate of 0.51-0.54 kg per 1-kg thrust per hr has been developed. Middle-range Tu-124 passenger airplanes powered by turboprop engines have a fuel-consumption rate 15-25% lower than Tu-104 airplanes
Author (TAB)

N69-26532# Von Karman Inst. for Fluid Dynamics, Rhode Saint-Genese (Belgium).
AERODYNAMIC PROBLEMS IN COOLED TURBINE BLADING DESIGN FOR SMALL GAS TURBINE
J. Chauvin, K. Papailiou, and L. Burrows (Army Aviation Mater. Labs.) *IN* AGARD Advan. Components for Turbojet Eng., Pt. 2 Sep. 1968 22 p refs
Avail: CFSTI

The next generation of small gas turbines (in the 500 to 1000 shp range) will have to use turbine inlet temperatures of the order of 1200°C, if specific fuel consumption and specific power better than those of piston engines must be reached. Such temperatures can be realized only if cooling of the nozzle and blades of the compressor turbine is used. Air and liquid cooling are being considered. Strength and space requirement lead to the use of thick blades, especially at the trailing edge, and having a minimum chord length of several centimeters. The mass flow to handle leads to small passages height and therefore to aspect ratios of the order of 0.4. High losses are generated due to blade profile, trailing edge thickness and above all, secondary losses. A review is made of the research in the field of blade optimization and in the analysis and reduction of secondary flows and losses, (wall shaping etc.).
Author

N69-26620# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
ELEMENTS OF THE GENERAL THEORY OF TRANSIENT WORK PROCESSES OF LIQUID-METAL MHD CONDUCTION TYPE GENERATORS
A. N. Patrashev, A. G. Ryabinin, and A. I. Khozhainov 12 Jul. 1968 45 p refs Transl. into ENGLISH OF Akad. Nauk SSSR, Inst. Vysokikh Temperatur (USSR) 33 p
(AD-680712; FTD-HT-23-586-68) Avail: CFSTI CSCL 10/2

The theoretical research is applicable to a laminar flow regime of the liquid metal in the channel of an MHD generator. These flow conditions can be the working conditions. In addition, at high speeds of the liquid metal the flow conditions can be turbulent. An analysis of the attained solutions has made it possible to establish that during laminar flow conditions of a liquid metal, for a description of the change with respect to time of the integral parameters of the flow, one can successfully make use of a quasi-stationary approximation taking into account frictional forces. Author (TAB)

N69-27071# Stanford Univ., California. Plasma Gasdynamics Lab.
ELECTRODE TEMPERATURE EFFECT ON MHD GENERATOR PERFORMANCE
R. H. Eustis, M. Mitchner, and C. H. Kruger Wright-Patterson AFB, Ohio AFAPL Jan. 1969 63 p refs
(Contract F33615-67-C-1127)
(AD-683793; SU-IPR-274; AFAPL-TR-68-141) Avail: CFSTI CSCL 10/2

Five segmented electrode pairs capable of controlled temperatures between 700K and 1700K were mounted at the downstream end of the MHD channel. The temperature of the electrode wall upstream of the electrode was controlled at two values, 750K and 2400K. By means of probes mounted in the sidewall, it was possible to measure the voltage drop at the electrodes due to the combined boundary layer and surface-sheath effects. Results showed that hot electrodes performed considerably better than cold electrodes and that anode voltage losses were largely due to boundary-layer losses while cathode losses were caused by boundary-layer and surface-sheath effects. Computer calculations were made to show the effect of electrode size for three types of gas conductivity profiles corresponding to no thermal boundary-layer and cold and hot boundary-layers. Spectroscopic measurements of the boundary-layer temperature showed that the profile could be represented by a power-law enthalpy profile with the exponent equal to 1/8. An experiment was made to determine if finite recombination rates had a significant effect in combustion MHD generators. Techniques were investigated for measuring electron temperature and number density in combustion gas plasmas.
Author (TAB)

N69-27397# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
THE ENIN-2 EXPERIMENTAL OPEN-CYCLE MHD GENERATOR RIG [EKSPERIMENTALNAYA USTANOVKA MGD-GENERATORA OTKRYTOGO TSIKLA ENIN-2 SM-107/159]
D. G. Zhimerin et al 12 Aug. 1968 14 p Transl. into ENGLISH from Russian publication
(AD-683131; FTD-MT-24-175-68) Avail: CFSTI CSCL 10/2

An experimental rig has been set up to study the processes taking place in the duct of an open-cycle MHD generator. The installation consists of a combustion chamber unit in which natural

gas is oxidized in an air atmosphere enriched in oxygen (up to pure O2) with ionizing seeds of different types. The pressure in the duct can go up to 50 atm and the temperature to 3500K. As the combustion products pass into the duct, the nozzle system can vary the Mach number from subsonic to Mach 3. The duct has a rectangular section. Its maximum dimensions, determined by the magnet bore, are 0.2 x 0.34 x 2.5 m. The ducts are interchangeable to give the possibility of varying the area modification law relating to the section along the axis of the duct and of altering the electrode circuit or the size of the electrodes or insulation gaps, etc. The combustion chamber, nozzle and duct are made of stainless steel and are water-cooled; a coating of aluminum oxide serves as insulation. Depending on the mode of operation, the installations calculated power and electric power are in the neighborhood of 250 MW and 10 MW, respectively. TAB

N69-27494# Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires.
PEGASE REACTOR LOOPS [LES BOUCLES DU REACTEUR PEGASE]
Nov. 1968 115 p In FRENCH
(CEA-R-3564) Avail: AEC Depository Libraries

The first 4 years operation, experimentation and maintenance of the gas loops built especially for the nuclear fuel testing reactor Pegase are described. The reasons for the technical modifications and the way in which they were carried out are also described. Author (NSA)

N69-28597# European Nuclear Energy Agency, Paris (France).
MHD ELECTRICAL POWER GENERATION Status Report, 1969
Apr. 1969 67 p refs
Avail: CFSTI

The current status of MHD electrical power generators is reviewed with its application to large-scale, commercial power generation receiving primary consideration. The open cycle system in which the working fluid is a plasma formed by seeded combustion products has received most attention because of its near-term applicability to fossil fueled power plants. Model generators with electrical outputs of up to 30 MW have been operated for short times in good agreement with predicted performance, and long duration operation of the generator and other components has been demonstrated for periods of over 100 hours on a small scale. The efficiency of a full-scale, open cycle installation would initially be in the range 48% to 50% for a combined MHD-steam cycle and improvements in technology could later increase this to 60%. Closed cycle systems may be operated with either a seeded noble gas plasma or a liquid metal in the MHD generator. In the case of plasma systems, the necessary hot electron plasma has now been obtained. Liquid metal systems of improved efficiency and a prototype system for space vehicle applications are under development. Author

N69-28635# California Univ., Livermore. Lawrence Radiation Lab.
ONE-DIMENSIONAL CALCULATIONS ON A FINITE-LENGTH MHD INDUCTION CONVERTER
Myron Heusinkveld 30 Oct. 1968 71 p refs
(UCRL-50537) Avail: CFSTI

A linear induction converter is considered here, involving the flow of a liquid metal, through a narrow channel across which an ac magnetic field is impressed. Electrical currents are induced in the fluid, which react back on the field windings to generate electrical power. The magnetic field relations are solved in the one-dimensional approximation, in which the magnetic field and the fluid velocity are uniform across the gap. The equation for the total magnetic induction B_t is deduced from Faraday's law. The solution of this equation is found. From this solution, equations are obtained for electrical impedance of the excitation winding, hydrodynamic power input, real and reactive electrical power output, real and reactive electrical power output, and the energy conversion efficiency. Results of numerical calculations of the problem of a uniform traveling-wave generator of finite length are presented. These results include magnetic field distribution, electrical impedance, and conversion efficiency as a function of magnetic Reynolds number, generator slip, converter length in wavelengths, and end current. NASA(Author)

N69-28781# Union Carbide Corp., Parma, Ohio. Development Dept.
HYDRAZINE-AIR FUEL CELL CONTROLS
G. E. Evans 1968 12 p
(AD-684339) Avail: Issuing Activity CSCL 10/2

One of the major areas researched for hydrazine-air fuel cell controls has been the testing and qualification of new parts and components, designed for better compliance with environmental and performance specifications. The principal work was to transform a power source which was functional-in the sense of delivering the proper number of volts and amperes-into a power source which remains functional, but now conforms more closely with military application requirements. TAB

N69-29842# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
EXPERIMENTAL INVESTIGATION OF THE INFLUENCE OF BOUNDARY LAYERS AND CERTAIN OTHER EFFECTS ON THE CHARACTERISTICS OF AN MHD GENERATOR
A. E. Sheindlin et al Aug. 1968 31 p refs Transl. into ENGLISH of the publ. "Eksperimentalnoe Issledovanie Vliyaniya Pogranichnykh Sloev i Nekotorykh Drugikh Effektov na Kharakteristiki Mgd-Generatora" p 1-31
(AD-685536; FTD-MT-24-177-68) Avail: CFSTI CSCL 10/2

The paper deals with the results of research on the electrical characteristics of an MHD generator, carried out in a model power plant using the U-02 MHD generator. In this device was tested different types of MHD ducts which vary both in design and in the structural materials used for the electrodes and the insulating walls. As a result of this work the power of the generator was raised to 42 kW and the operating time was taken to 100 hours. The maximum power extracted from a single pair of electrodes has reached 2.5 kW and the current density at the electrodes is 2.5 A/sq cm (in the short-circuiting regime). A great deal of experimental data was accumulated during the development and testing of the duct designs, and the paper is devoted to an analysis of this information. The object of study is a Faraday-type MHD generator with segmented electrodes, operating in a subsonic gas-dynamic regime. Author (TAB)

N69-29843# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
OPTIMUM GEOMETRIC RELATIONSHIPS IN A COAXIAL LINEAR INDUCTION AND MHD GENERATOR
N. M. Okhremenko et al Aug. 1968 27 p refs Transl. into ENGLISH of the publ. "Optimalnie Geometricheskie Sootnomeniya v Koaksyalnom Lineinom Inluktsionnom Mgd-Generatore SM-107/174" USSR p 1/21
(AD-685523; FTD-MT-24-173-68) Avail: CFSTI CSCL 10/2

Mathematical treatment of design problems for the asynchronous coaxial MHD generator with liquid-metal (Na, K) working fluid and unilateral or bilateral excitation at outputs of 5kw-150mw. TAB

N69-29892# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
RAYLEIGH-TAYLOR INSTABILITY IN LIQUID-METAL

SYNCHRONOUS MHD GENERATORS AND METHODS OF STABILIZING IT
K. I. Kim 30 Aug. 1968 19 p refs Transl. into ENGLISH from Neustoychivost Releya-Teilora v Zhidkomet. Sinkhronnykh Mgd Generatorakh i Sposoby Yeye Stabilizatsii (USSR)
(AD-685487; FTD-MT-24-174-68) Avail: CFSTI CSCL 10/2

Use of piston-type flow in liquid-metal MHD systems is proposed in order to counteract Rayleigh-Taylor instability. Two main advantages are cited: (1) difficulties connected with acceleration are excluded inasmuch as the generating of electrical energy is guaranteed basically because of the gas expansion in the generator duct itself; flow rate can be more moderate, impossible in systems with continuous flow and noticeably reduced hydraulic losses; (2) in view of the small contact surface between liquid metal and gas and the low coefficient of temperature transfer of gas, a lower temperature of the thermodynamic cycle can be selected independently of the temperature of hardening of the liquid metal, consequently, there appears a possibility of a noticeable increase of the thermal efficiency of the cycle; (3) the possibility appears of realizing the powerful effective and technically perfected synchronous principle of conversion of flow kinetic energy into electrical energy. These features show that a liquid-metal MHD system with piston flow and with electrical energy takeoff by the synchronous principle will be high-power. Author (TAB)

N69-29923# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
EXPERIMENTAL INVESTIGATION OF ELECTRICAL CONDUCTIVITY OF PRODUCTS OF COMBUSTION, STIMULATED BY SOLID PARTICLES
E. P. Zimin et al 23 Aug. 1968 23 p refs Transl. into ENGLISH from Eksperim. Issled. Elektroprovodnosti Produktov Sgoraniya, Stimulirovannoy Tsvedymi Chastitsami (USSR)
(AD-685511; FTD-MT-24-183-68) Avail: CFSTI CSCL 10/2

An experimental study was carried out on the electrical conducitivity c• the products of combustion of methane with oxygen-enriched air in the presence of solid particles of various substances. This question merits attention in connection with the use of MHD electric power generators. By artificially introducing solid particles it was found possible to improve the electrophysical properties of the working gas. Solid particles transported from the combustion chamber may be present in the duct of an open-cycle MHD generator working with the products of coal combustion. In addition, when there are sufficiently large temperature reductions in the rear part of the duct, particles may form through the condensation of combustion product volatiles directly into the solid phase. The experiments showed that the introduction of particles stimulates the electrical conductivity of the products of methane combustion which, without particles, are non-conducting. The dependence of electrical conductivity on gas temperature and on particle size and the relative mass flow rate of the particles was studied. Author (TAB)

N69-30078# Commissariat à l'Energie Atomique, Limeil (France).
STUDY OF THE ELECTRICAL BEHAVIOR OF VARIOUS MAGNETOHYDRODYNAMIC GENERATORS USING EXPLOSIVES [ETUDE DU COMPORTEMENT ELECTRIQUE DE DIFFERENTS GENERATEURS MAGNETOHYDRODYNAMIQUES A EXPLOSIF]
Jean Bernard and Jean-Claude Jouys Apr. 1969 80 p refs In FRENCH; ENGLISH summary
(CEA-R-3714) Avail: CFSTI

This report concerns the electric behavior of several types of pulse generators which use the M.H.D. conversion of explosive chemical energy to supply experiments on plasma physics. Their electric parameters and behavior on ohmic and inductive loads are studied and compared. The electrical energy which appears on the load is studied in respect of load and generator characteristics. Ways of amplifying the initial electric energy is also discussed. Author (ESRO)

N69-30871*# Thermo Electron Corp., Waltham, Mass.
HYDROGEN-OXYGEN FIRED THERMIONIC GENERATORS AND THERMIONIC DIODES
3 Apr. 1969 67 p
(Contract NAS9-4282)
(NASA-CR-101745; TE-5045-145-69) Avail: CFSTI CSCL 20M

The hardware described in this paper served to evaluate the state-of-the-art of thermionic flame-heated devices for use in a short (a few hours to a few days) space mission. The reactants available as fuel and oxidant in the mission were expected to be hydrogen and oxygen, and these same reactants were employed in this work. Two hydrogen-oxygen 50 watt generators and two spare thermionic diodes were built. Although the generators were successfully operated, their efficiency was far below that initially expected. Self-bonded silicon carbide was the only material available that could resist the high temperatures and the thermal shock. This material was found highly permeable to hydrogen, and this precluded the design of a truly efficient combustor. Use of vapor-deposited silicon carbide, either free-standing or as a coating, is recommended as a way of circumventing the above difficulty in future devices. Author

N69-31249# Technische Hogeschool, Eindhoven (Netherlands). Afdeling der Elektrotechniek.
MHD POWER CONVERSION EMPLOYING LIQUID METALS
J. W. M. A. Houben and P. Massee Feb. 1969 34 p refs
(TH-69-E-06) Avail: CFSTI

The work described was performed in the field of MHD generation of electricity by means of liquid metals. It is shown that the study of two-phase flows is essential in this topic of research. Two types of generators which can be utilized with liquid metals were studied. The results are described. A short survey of the prospects of other liquid metal systems, which emerge from a study of the literature, is given. Finally, conclusions are drawn concerning possibilities for further investigation. Author

N69-32347# Defense Documentation Center, Alexandria, Va.
MAGNETOHYDRODYNAMIC GENERATORS, VOLUME 1 Report Bibliography, 1953–1968
Mar. 1969 259 p
(AD-686000; DDC-TAS-69-5-Vol-1) Avail: CFSTI CSCL 10/2

This is Volume I of a two-volume set on Magnetohydrodynamic Generators (MHD). It has been prepared from the DDC collection and covers a period from 1953 to December 1968. It contains 211 unclassified and unlimited references and computer generated indexes of Corporate Author-Monitoring Agency, Personal Author, and Contract number. Author (TAB)

N69-32553*# General Electric Co., Schenectady, N.Y. Research and Development Center.
CHARACTERISTICS OF A THERMIONIC CONVERTER WITH A CHLORIDE VAPOR DEPOSITED TUNGSTEN EMITTER (110) AND A NICKEL COLLECTOR
V. C. Wilson and S. P. Podkulski Washington NASA Aug. 1969 37 p refs
(Contract NAS3-8511)
(NASA-CR-1416; GESP-9001) Avail: CFSTI CSCL 10A

A chloride vapor-deposited (110) tungsten emitter with a vacuum work function of 4.96 eV was built into a 0.005-inch-spaced converter with a nickel collector. The I–V curves

for emitter temperatures of 1673°K to 2153°K are presented. The output power versus emitter temperature is compared with three other similar converters. This converter yielded almost the same output power as a converter with a single-crystal (110) tungsten emitter, 0.002-inch spacing and a molybdenum collector. The vapor-deposited (110) tungsten surface was found to be extremely stable. The collector work function was observed to decrease when the device was left at room temperature for one month. Author

N69-32804# Naval Radiological Defense Lab., San Francisco, Calif.
RADIOISOTOPIC POWER GENERATORS State of the Art Report
Francis J. Berlandi, Francis K. Kawahara, J. Kim, and V. E. Schrock Aug. 1968 340 p refs
(AD-687131; USNRDL-R/L-68-10) Avail: CFSTI CSCL 10/2

A state-of-the-art compilation of radioisotopic power generators are summarized with respect to fuels, conversion devices, and overall system design performance through 1966. The fuel data is listed according to isotope mass number. The conversion devices discussed are thermoelectric, thermionic, Brayton, Rankine, and Stirling cycles. The systems section lists the major features that characterize RPG units in use in this country. Author (TAB)

N69-32934# Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium).
COMPILATION OF REFERENCES ON THE DIRECT CONVERSION OF HEAT INTO ELECTRICAL ENERGY
J. P. Contzen and P. Bemelmans Jul. 1968 208 p refs *In* FRENCH
(BLG-427) Avail: AEC Depository Libraries

A collection of a little over one thousand references is presented, dealing with the production of electrical energy by direct conversion from a heat source. The period of time covered extends up to the years 1963–1964. The references are sorted out under main headings and subheadings, according to the conversion mode and to the particular aspect investigated. Author (NSA)

N69-34199# Akademiya Nauk URSR, Kiev. Inst. Teoreticheskoi Fiziki.
EFFECT OF ELECTRON SCREENING ON THERMONUCLEAR REACTIONS UNDER HIGH DENSITIES
V. V. Porfirev and Yu. N. Redkoborodyi 1969 30 p refs
(ITF-69-7) Avail: AEC Depository Libraries

The effect of electron screening of the Coulomb field of nuclei, which increases the thermonuclear fusion rate, is considered. The effective potential is derived by means of the self consistent field method based on the Hartree–Fock approximation. The influence of reacting nuclei on distribution of the screening space charge of electrons is taken into consideration. The screening contribution to interaction energy of colliding nuclei depends essentially on the self energy of the screening electron cloud. The results differ greatly from the results of other authors. Author (NSA)

N69-34810*# Pennsylvania Univ., Philadelphia. Inst. for Direct Energy Conversion.
INSTITUTE FOR DIRECT ENERGY CONVERSION Status Report
Dec. 1968 62 p refs (Grant NGL-39-010-001)
(NASA-CR-103989; INDEC-SR-15) Avail: CFSTI CSCL 07D

CONTENTS:

N69-34812*# Pennsylvania Univ., Philadelphia. Inst. for Direct Energy Conversion.
PLASMA ENGINEERING
In its Inst. for Direct Energy Conversion Dec. 1968 13 p ref

Avail: CFSTI CSCL 20D

Thermoelectric properties of barium-graphite compound synthesized by diffusion anneal are discussed. The lattice parameters of C_8Ba were determined by Debye-Sherrer techniques. The MHD flow in an annular gap, basic surface investigations, and a materials study of silicon solar cells are also reported. J.A.M.

N69-34813*# Pennsylvania Univ., Philadelphia. Inst. for Direct Energy Conversion.
ELECTROCHEMICAL ENGINEERING
In its Inst. for Direct Energy Conversion Dec. 1968 17 p ref

Avail: CFSTI CSCL 07D

Using the bilinear transformation of coordinator, the cylindrical configuration was reduced to one of concentric circles for which the current distribution was solved and expressed in the original geometry in terms of simple analytical expressions. This was applied to fuel cell designs. The improved design of the foam fuel cell was used for anodic oxidation studies of hydrogen in 4N H_2SO_4 on bright, smooth platinum electrodes. The iodine cathode composed of graphite and magnesium in fuel cells is discussed, including its leadage which was a major retarding factor due to the incompatibility of most materials with iodine. Overpotential transients on the rotating disk are also assessed. J.A.M.

N69-34989*# Avco Corp., Wilmington, Mass. Government Products Group.
ISOTOPE REENTRY VEHICLE DESIGN STUDY PRELIMINARY DESIGN: PHASE 2 Final Report
Richard L. Ryan and John W. Graham Aug. 1969 466 p refs
(Contract NAS3-10938)
(NASA-CR-72555; AVSD-0306-69-RR) Avail: CFSTI CSCL 22B

Preliminary design efforts to develop a 25 kW_t (end-of-life) Pu 238 heat source Isotope Reentry Vehicle (IRV) are summarized. The emphasis was placed on feasibility and safety considerations. Heat source and heat source exchanger concept combinations were developed, and three of the more promising combinations were evaluated at the conceptual design level. The analytical evaluation included systems analysis, reentry performance, and heat source design as well as IRV heat shield, aeroshell structure, and thermal control. Design, performance, insulation, and structural details of the heat source heat exchanger were considered. The integration of the IRV system with the Brayton cycle power system, overall integration with the spacecraft, and ground handling requirements were also analyzed. K.W.

N69-35224# Forsvarets Forskningsanstalt, Stockholm (Sweden).
ELECTRICAL POWER PRODUCTION BY MEANS OF MHD, PRESENT SITUATION AND FUTURE PROSPECTS [ELKRAFTPRODUKTION GENOM MHD, NUVARANDE LAEGE OCH FRAMTIDSUTSIKTER]
E. Witalis Nov. 1967 14 p In SWEDISH
(FOA-4-C-4325-55) Avail: CFSTI

The research during recent years on magnetohydrodynamic energy conversion for commercial electric power production is briefly reviewed. Power requirements, costs, and efficiency of MHD generators are compared with conventional power generating systems. Experimental open-loop MHD generators, the closed-loop

system, gas transport, and future potentials are discussed in somewhat more detail. Potential applications on ships, in aircraft, and in spacecraft are also briefly considered. Transl. by K.W.

N69-35280# Army Foreign Science and Technology Center, Washington, D.C.

MAGNETIC SYSTEMS USING STEEL FOR MAGNETOHYDRODYNAMIC GENERATORS

O. B. Bull 17 Apr. 1969 17 p ref Transl. into ENGLISH from Iz. Vyssh. Ucheb. Zaved., Elektromekhan. (Novocherkassk), no. 12, 1967 p 1330–1340

(AD-688393; FSTC-HT-23-568-68) Avail: CFSTI CSCL 20/9

Several designs for magnetic systems which can be employed in a magnetohydrodynamic generator, used to convert heat energy directly into electrical energy are analyzed. A design method is described for an annular magnetic system, the results of calculations are shown, and the system is compared in its basic parameters with a rectilinear magnetic system intended for a magnetohydrodynamic generator of the same power. Author (TAB)

N69-35732*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

ANALYTICAL AND EXPERIMENTAL STUDIES OF MHD GENERATORS CATHODES EMITTING IN A "SPOT" MODE

Lester D. Nichols and Maris A. Mantenieks Washington Sep. 1969 refs

(NASA-TN-D-5414) Avail: CFSTI CSCL 20I

The sheath current-voltage characteristics for a plane cathode emitting current from a thermionic arc spot are derived. The derivation is based upon the requirement of energy conservation at the cathode spot and also in an ionization region adjacent to the spot. The results for given gas conditions and electrode work function predict a sheath voltage which decreases with both increasing current for a fixed undisturbed (i.e., far from the spot) cathode temperature, and increasing disturbed cathode temperature at a fixed current. Experimental data is shown which supports the conclusions predicted by the model. Author

N69-35785# Aktiebolaget Atomenergi, Stockholm (Sweden).

THERMODYNAMIC ANALYSIS OF A SUPERCRITICAL MERCURY POWER CYCLE

A. S. Roberts, Jr. Apr. 1969 26 p refs

(AE-355) Avail: CFSTI

A heat engine is considered which employs supercritical mercury as the working fluid and a magnetohydrodynamic (MHD) generator for thermal to electrical energy conversion. The temperature range is approximately 300 to 2200°K and system pressure is 1500 atm. Equilibrium and transport properties are carefully considered since these are known to vary radically in the vicinity of the critical point, which is found near the supercritical states of interest. A maximum gross plant efficiency is 20% with a regenerator effectiveness of 90% and greater, a cycle pressure ratio of two, and with highly efficient pump and generator. However, certain specified cycle irreversibilities and others such as heat losses and heat exchanger pressure drops, which are not accounted for explicitly, reduce the gross plant efficiency to a few per cent. Experimental efforts aimed at practical application of the power cycle are discouraged by the marginal thermodynamic performance predicted by this study, unless such applications are insensitive to gross cycle efficiency. Author (ESRO)

N69-37703*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

REVIEW OF LIQUID-METAL MAGNETOHYDRODYNAMIC ENERGY CONVERSION CYCLES

Frederick H. Morse (Maryland Univ., College Park) Aug. 1969 53 p refs

(NASA-TM-X-63671; X-716-69-365) Avail: CFSTI CSCL 10A

Interest in liquid-metal magnetohydrodynamic (LM MHD) power generation has developed because of its high power density, its ability to operate both ac and dc generators, and the possibility of operation at moderate temperatures. Recent efforts and advances in LM - MHD have made the evaluation of such systems for spacecraft power supply feasible. In this report all of the reported LM MHD power generation cycles are described and their efficiencies compared. A brief summary of the evolution and status of the LM MHD power generation systems and a listing of facilities engaged in LM MHD is also included. Author

N69-37883*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

EFFECT OF ELECTROTHERMAL INSTABILITIES ON BRAYTON- AND RANKINE-CYCLE MAGNETOHYDRODYNAMIC SPACE-POWER GENERATION SYSTEMS

Allan R. Bishop and Lester D. Nichols Washington Oct. 1969 18 p refs

(NASA-TN-D-5461) Avail: CFSTI CSCL 10B

Plane wave electrothermal instabilities are included in the analysis of idealized Brayton- and Rankine-cycle magnetohydrodynamic generators. It is shown that the instabilities cause an increase in Joule heating and a reduction in output power. An increase in the magnetic field can compensate for the reduction in output power. Author

N69-38033# Sandia Corp., Albuquerque, N.Mex. Aerospace Radioisotope Power Information Center.

SELECTED THERMOELECTRIC, THERMIONIC, AND ELECTRON-VOLTAIC ENERGY CONVERSION DEVICE CHARACTERISTICS

H. J. Gerwin (comp.) May 1969 27 p refs Sponsored by AEC

(SC-ARPIC-1011) Avail: CFSTI

Information on thermoelectric, thermionic, and electron-voltaic energy conversion devices that are commercially available or are in the prototype stage of development is presented. Included are certain devices for use in space, terrestrial, and marine environments. Technical data, applications of devices, and general cost information are included. Author (NSA)

N69-38506# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.

POTENTIAL OF USING MIXED FISSION PRODUCTS AS A SOURCE OF ENERGY

D. W. Bolme Jun. 1969 54 p refs

(Contract AT(45-1)-1830)

(BNWL-1115) Avail: CFSTI

The amount of mixed fission products (waste byproducts obtained in the chemical reprocessing of nuclear fuels) potentially available through the year 2000 was estimated, their probable characteristics when packaged in a form suitable for long term storage described, and the potential usefulness of these packages as sources of thermal and gamma (radiation) energy assessed. The amounts potentially available depend upon the development of the nuclear (electric) power industry. Initial availability could be as early as 1975, substantial amounts (4800 packages per year) are expected to be available in about 1990. Packaging the waste will consist of converting the waste to a solid and depositing the solid in a metal cylinder which would then be welded shut. Author (NSA)

N69-38756*# Aztec School of Languages, Inc., Acton, Mass. Research Translation Div.

THE BASIC PRINCIPLES FOR OPTIMUM SHIELDING OF NUCLEAR APPARATUS ON BOARD SPACECRAFT

L. N. Veselovskiy et al *In its* Probl. of Space Biol., Vol. 6 Jul. 1969 p 532–539 refs (See N69-38701 23-05)
Avail: CFSTI CSCL 18I

Principles for planning protection from nuclear apparatus on board spacecraft are established: the necessity is shown for changing and supplementing the approaches for designing shielding of stationary nuclear reactors. Particular attention is given to the selection of criteria for radiation safety. These criteria are highly important in formulating the problem of optimization of the shield, for the purposes of achieving its minimum possible weight. The principles presented in the article allow for considering the particular features of using reactors on board the spacecraft.
Author

N69-39863# Florida Univ., Gainesville. Dept. of Nuclear Engineering Sciences.
STUDY OF NUCLEAR SEEDED MHD PLASMAS Yearly Summary Technical Report No. 3, 1 May 1967–31 Nov. 1968
William H. Ellis Nov. 1968 339 p refs
(Contract Nonr-580(18))
(AD-690542) Avail: CFSTI CSCL 20/9

The characteristics of MHD working media are investigated from several different aspects. A new method for studying electron kinetics in plasmas produced by neutron irradiation of He3, the pulsed ionization chamber technique, is described in detail. Plasma production and loss coefficients for a range of helium gas pressures from 1-10 atmospheres are presented for steady state plasmas measured by this technique. The dynamics of the diffusion and recombination of ion columns are investigated analytically and numerically. The systematics of the formation of a quasineutral plasma in a hydrodynamic channel flow are considered. Also studied are the required nuclear properties of a reactor system for use with the nuclear seeding technique of MHD plasma production.
Author (TAB)

N69-39898*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
TRIODE THERMIONIC ENERGY CONVERTER
Alex Vary, inventor (to NASA) Issued 27 May 1969 (Filed 22 Oct. 1965) 7 p Cl. 310-4
(NASA-CASE-XLE-1015; US-Patent-3,446,997;
US-Patent-Appl-SN-502746) Avail: US Patent Office CSCL 10A

A new and improved vacuum thermal-to-electrical energy converter is described which converts heat energy directly into electrical energy. The converter has three electrode elements, namely an emitting, a collecting, and a biased electrode; they are geometrically arranged and electrically interconnected in such a manner as to utilize the short circuit characteristics of the converter to increase substantially the electron transmission and hence the energy conversion efficiency of the converter. The electron-emitting electrode is located adjacent to the collector electrode, which has openings allowing electrons to pass and impinge on the bias electrode. The bias and emitter electrodes are directly connected, causing a short circuit condition in which the converter operating point is located on the high current portion of the converter's output characteristic curve. The collector bleeds off some of the electron flow and diverts it to a variable load impedance connected between collector and emitter electrodes, thereby energizing the load impedance. The electrodes may be flat or cylindrical and may be arranged in-parallel or coaxially.
NASA

N69-39983*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
SLUG FLOW MAGNETOHYDRODYNAMIC GENERATOR
Yih-Yun Hsu, inventor (to NASA) and John W. Dunning, Jr., inventor (to NASA) Issued 1 Jul. 1969 (Filed 27 Jul. 1966) 5 p Cl. 310-11
(NASA-Case-XLE-2083; US-Patent-3,453,462;
US-Patent-Appl-SN-568362) Avail: US Patent Office CSCL 10B

A magnetohydrodynamic generator in which a heated nonconductive gas of high kinetic energy and a liquid metal mist of high kinetic energy are directed from a mixing chamber to a magnetohydrodynamic generator in such proportions that the liquid metal coalesces into slugs of metal. The slugs of metal are separated by pockets of the nonconductive gas whose kinetic energy aids in the movement of the slugs through the magnetohydrodynamic generator to generate an electric current at output electrodes of the generator. After leaving the generator, the slugs of metal are separated from the nonconductive gas. The liquid metal and the gas are recirculated through suitable heat exchangers to increase their respective kinetic energies.
Official Gazette of the U.S. Patent Office

N69-40031# California Univ., Berkeley. Coll. of Education.
HEAT TRANSFER FROM RADIOISOTOPIC POWER SOURCES IN POROUS MEDIA
V. E. Schrock, T. Fernandez, S. Garribba, and S. Narra Jun. 1968 96 p refs
(Contract N00228-68-C-0554)
(AD-691213; NE-68-1) Avail: CFSTI CSCL 18/14

Heat transfer from radioisotopic full fuel capsules was studied experimentally and analytically for the situation in which the capsule is buried in a porous earth material saturated with water as would occur when such a capsule becomes accidentally buried in the ocean floor. Experimental conditions have been extended beyond the range reported previously by testing devices with different length-diameter ratios and using a greater range of burial depths. The previously reported correlation for natural convection has been modified to include the greater range of parameters and the effect of length to diameter ratio. Theoretical treatment of the free convection case has been studied to establish the validity of the basic equations governing the system. Data have been obtained and analyzed for the nucleate boiling regime. Additional data have been obtained for the dryout condition and on the formation of crusts on the capsule.
Author (TAB)

N69-40586# Commissariat à l'Energie Atomique, Saclay (France). Centre d'Etudes Nucléaires.
ONE VOLT ISOTOPIC MICROGENERATORS [LES MICROGENERATEURS RADIOISOTOPIQUES 1 VOLT]
Robert Bomal, Bernard Devin, and Philippe Delaquaize Jun. 1969 75 p refs In FRENCH; ENGLISH summary
(CEA-R-3834) Avail: CFSTI

Various configurations for electrical isotopic generators in the milliwatt range are investigated: these generators are not of the classical thermoelectric type. The four following energy conversion methods are examined: (a) Thermionic, (b) Thermophotovoltaic, (c) Radiovoltaic and (d) Wired thermoelectric. Calculations were conducted with the aim of obtaining directly 1 volt output voltage and not with the best energy conversion efficiency. High temperature ^{238}Pu sources (T above 1000°K) were isolated by multilayer thermal insulation materials of the Moly/Alumina type. Optimised application is given for (a) and (b) above. The thermionic method is interesting due to its compactness and the wired-thermoelectric one is cheap, simple and rugged. Both methods do not give output voltages far above 1 volt. The other two methods can be designed for multivolt application. The radiovoltaic one is 1 per cent efficient but irradiation defects in the semiconductor induced by high energy radiations can strongly limit the lifetime of the generator. Isotope source technology is the determining factor for these microgenerators.
Author (ESRO)

N69-40792# Naval Research Lab., Washington, D.C.
CONTROLLED THERMONUCLEAR REACTIONS: AN OCEAN OF ENERGY
R. Sagdeev 16 Jul. 1969 4 p Transl. into ENGLISH from Izv.

(Moscow), v. 52, no. 3, Jan. 1969 p 1–4
(AD-691465; NRL-Trans-1175) Avail: CFSTI CSCL 18/1

The paper is a brief discussion of progress being made toward using thermonuclear power. TAB

N70-10447# Army Electronics Command, Fort Monmouth, N.J.
FAST TRANSIENT RESPONSE FUEL CELL-BATTERY HYBRID POWER SOURCE
Galen R. Frysinger Jan. 1969 5 p refs Presented at the Intern. Automotive Eng. Congr., Detroit, 13-17 Jan. 1969
(AD-692538) Avail: CFSTI CSCL 10/2

The integration of a molten carbonate fuel cell with a molten electrolyte battery both electrically and thermally produces a highly efficient power source with a fast transient response. Since most practical high pulse applications utilize electronic chopping circuits, microsecond and millisecond response characteristics of a power source are of importance. Ceramic monoblock construction of a hybrid package can be designed with optimum response characteristics as well as the ability to accept high reverse power flow. Author (TAB)

N70-11301# European Space Research Organization, Paris (France).
PROCEEDINGS OF THE SIXTH ESRO SUMMER SCHOOL, VOLUME 6: SPACE POWER SYSTEMS: INTRODUCTION
Jul. 1969 108 p refs Partly in FRENCH and partly in ENGLISH Conf. held at Noordwijk, Neth., 1968
(ESRO-SP-45) Avail: CFSTI

CONTENTS:

N70-11304# Centre National d'Etudes Spatiales, Brétigny-sur-Orge (France).
ISOTOPIC ENERGY SOURCES [LES SOURCES D'ENERGIE ISOTOPIQUE]
H. Daspet *In* ESRO Proc. of the 6th ESRO Summer School, Vol. 6: Space Power Systems: Introduction Jul. 1969 p 57–78 refs In FRENCH
Avail: CFSTI

After describing two kinds of energy sources the even-SNAP (fission) and the uneven SNAP (radio-active decay) the specific power of uneven SNAP and also conditions which the radio element must satisfy (cost, toxicity, life) are analyzed. Peltier and Thomson effects are discussed and the actual efficiency of the thermoelectric conversion is calculated. General characteristics of thermoelectric generators, of which SNAP is an example, lead to the conclusion that these devices are very suitable for long duration missions or for missions in shaded regions. The high cost of radioactive isotopes however will plead the case for use of solar generators for the missions which are at present envisaged. ESRO

N70-11305# Atomic Energy Establishment, Winfrith (England).
NUCLEAR REACTORS AS A SOURCE OF POWER IN SPACE
L. R. Shepherd *In* ESRO Proc. of the 6th ESRO Summer School, Vol. 6: Space Power Systems: Introduction Jul. 1969 p 79–108 refs
Avail: CFSTI

Three methods exist for converting the power generated in nuclear energy sources: the direct, the quasi-direct, and the indirect (or dynamic) methods. The direct method does not seem to be applicable to nuclear fission and is not discussed. The quasi-direct and indirect systems both work according to a thermodynamic cycle, but differ in that the quasi-direct system, using electrons for its working fluid, requires no moving parts, whereas the indirect system uses a material working fluid and thus needs rotating machinery. Indirect systems are discussed first and the use of conventional turbines considered. According to the level of power required, three possible arrangements are retained: a mercury Rankline cycle, noble-gas cycles, and MPD generators. Quasi-direct conversion is next discussed. The in-pile thermionic converter seems to be the most promising system for low-power ranges. In conjunction with the various conversion methods discussed, two types of moderated reactors are analysed, one employing graphite moderation and appropriate to the dynamic system, the other employing hydrogen or beryllium and appropriate to thermionic power conversion. It is concluded that the thermionic system, based on hydride-moderated reactors, could be designed with total mass of approximately one tonne and therefore suitable for a European launcher. As an alternative, a hybrid carbon/hydride reactor system with a gas turbine power cycle might be considered, while at very high power outputs the dynamic system might be more appropriate. Author (ESRO)

N70-11420# General Electric Co., Philadelphia, Pa. Space Sciences Lab.
INVESTIGATION OF A LARGE SCALE NON-EQUILIBRIUM MAGNETOHYDRODYNAMIC GENERATOR Annual Report, 1 Aug. 1968 31 Jul. 1969
B. Zauderer Aug. 1969 37 p
(Contract Nonr-3867(00))
(AD-693153) Avail: CFSTI CSCL 10/2

The report briefly summarizes efforts of the past contract year. The following tasks were completed: (a) Development of a uniform pre-ionization system; (b) Large scale MHD power generation in a non-equilibrium plasma; (c) Development of appropriate gas and plasma diagnostic methods for use in the MHD generator; (d) Development of a theoretical model to describe the generator performance; (e) Utilization of the above results to design and construct a new MHD channel. Author (TAB)

N70-11975*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
STUDY OF A 300-KILOWATT RANKINE-CYCLE ADVANCED NUCLEAR-ELECTRIC SPACE-POWER SYSTEM
Jack A. Heller, Thomas A. Moss, and Gerald J. Barna Washington Nov. 1969 37 p refs
(NASA-TM-X-1919; E-5135) Avail: CFSTI CSCL 21F

A system analysis is presented for a nominal 300 kW electric potassium system employing a lithium-cooled fast reactor and with 2100 F (1420 K) turbine inlet temperature. Trends in performance and weight are discussed for variations in design parameters. Performance and design of major components are reviewed, including material considerations. A typical conceptual system layout is shown. Author

N70-12638# California Univ., Livermore. Lawrence Radiation Lab.
CONTROLLED THERMONUCLEAR POWER
R. W. Werner, B. Myers, J. D. Lee, and P. B. Mohr 27 Jun. 1969 13 p refs Presented at 4th Intersoc. Energy Conversion Eng. Conf., Washington, D.C., 17-19 Sep. 1969 Submitted for publication Sponsored by AEC

(UCRL-71500; CONF-690905-1) Avail: CFSTI

A review is given of the elements of controlled thermonuclear power, the physics of containing a hot plasma, and the variety of proposed machines usable for a reactor. A reference design for a power-producing reactor is discussed which uses a lithium blanket surrounding the hot plasma to absorb energy and allow regeneration of the tritium fuel consumed in the basic reaction. A magnet surrounds the lithium blanket to provide a field for containing the plasma. The energy produced proceeds through a thermal conversion cycle, although there is the potential for direct electrical conversion. Author (NSA)

N70-13251# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

THE INTEGRAL CHARACTERISTICS OF AN MHD GENERATOR WITH DIVERGING ELECTRODES

I. V. Lavrentev 12 Mar. 1969 15 p refs Transl. into ENGLISH from Elektrofizicheskaya Apparatura (USSR), no. 6, 1967 p 83–93

(AD-694396; FTD-HT-23-1508-68) Avail: CFSTI CSCL 10/2

Edge effects in and integral characteristics of MHD-generators with a constant-cross-section channel and with finite-length electrodes were investigated. The article considers a MHD-generator whose working channel has radially diverging electrodes; both pressure and speed undergo drawdown. Formulas for the potential difference across the electrodes, usable power, Joules loss in the channel, and electrical efficiency are derived. Author (TAB)

N70-13293# Army Electronics Command, Fort Monmouth, N.J. Electronic Components Lab.

POWER SOURCES FOR LONG ECONOMIC LIFE COMMUNICATIONS EQUIPMENT

Galen R. Frysinger Jul. 1969 19 p

(AD-693847; ECOM-3154) Avail: CFSTI CSCL 10/2

Because of the extended life and operating endurance of new electronic communications equipment, new power sources must be designed and developed which provide no-break operation and optimum costs over these extended operating periods. The concept of a rack-mounted power source as a utility tray component of an integrated shelter is described. Maintainability and life cycle costs are developed for silent static power generation systems in contrast to present engine-generator units. Author (TAB)

N70-13348# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

THERMOELECTRIC POWER SUPPLIES

E. K. Iordanishvili Mar. 1969 199 p refs Transl. into ENGLISH from the Russian

(AD-690786; FTD-MT-24-53-69) Avail: CFSTI CSCL 10/2

The monograph examines the contemporary state of the problem of research and development of the most effective thermoelectric materials and methods of commutation, methods of design and investigation of semiconductor thermoelements, and also materials related to the development and use of domestic and foreign thermoelectric units, hydrometeorological, ground and space assignments. A special place is dedicated to a consideration of different aspects of the design, creation and application of cascade thermoelements, which at present play an important role in methods of thermoelectric generation of electric power. Inclusion of chapters expounding thermodynamic theory of thermoelectric generators and thermoelectric phenomena gives scientists and engineers a sufficiently full account of the whole contemporary state of this area of science and technology. The concluding part of the monograph examined prospects of the application of thermoelectric units of different designations and their possible combination with units which use other methods of direct conversion of thermal energy into electrical. A thematic bibliography complete up to 1967 embraces basic domestic works in the area of thermoelectric materials, thermoelements and thermoelectric units. TAB

N70-13927# Politecnico di Torino (Italy). Centro Studi Motorizzazione Agricola.

POSSIBILITIES AND PROBLEMS OF GAS TURBINE APPLICATION FOR GROUND MOTION MACHINES [POSSIBILITA E PROBLEMI DELL'APPLICAZIONE DELLE TURBINE A GAS ALLE MACCHINE PER MOVIMENTO TERRA]

Gianni Rigamonti and Fiorenzo Morra (Fiat) Assoc. Tec. Automobile Jun. 1969 19 p refs In ITALIAN Sponsored by Consiglio Nazl. delle Ric. *Its* Ric. ATA, Quaderno 69, Suppl. to No. 6

(Publ-18) Avail: CFSTI

The present state of development of gas turbine engines for surface propulsion through a mechanical transmission is outlined. The space/power and weight/power relationship and the operational characteristics are discussed, as well as the utilization of the prime mover as a power supply to the auxiliaries. For gas turbine drives special systems of motor braking must be devised and new problems are encountered in installation, noise level, air filtering and exhausts. ESRO

N70-14220*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

TURBINE PERFORMANCE IN A GAS-BEARING BRAYTON CYCLE TURBOALTERNATOR

Joseph S. Curreri, Roman Kruchowy, and James C. Wood Dec. 1969 16 p refs

(NASA-TN-D-5604) Avail: CFSTI CSCL 10A

The performance characteristics of the turbine for a gas-bearing Brayton cycle turboalternator were experimentally determined and compared with design predictions. Design operating conditions were inlet temperature, 1225 F; inlet pressure, 8.45 psia; total-to static-pressure ratio, 1.26; and shaft speed, 12 000 rpm. Performance data were obtained over a range of pressure ratios from 1.1 to 1.4 and at speeds of 10 000, 12 000, and 14 400 rpm. Author

N70-14488# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

CERTAIN DESIGN PECULIARITIES OF AUTOMOTIVE GAS TURBINES

Yu. I. Frieman et al 22 May 1969 20 p refs Transl. into ENGLISH from Akad. Nauk SSSR, Izv. Energ. i Transp. (USSR), no. 2, 1968 p 40–47

(AD-694842; FTD-MT-24-521-68) Avail: CFSTI CSCL 21/5

This paper examines design characteristics of automobile gas-turbine engines: the engines almost always operate at considerably below rated power and over a wide rpm range and they are often shifted from mode to mode and therefore must have good pickup. A twin-shaft turbine with heat exchanger is considered, but almost everything discussed applies to any automobile gas-turbine engine. It is shown that the rated pressure increase in the compressor must ensure minimum specific fuel consumption under average operating conditions. Selection of the basic engine parameters on the basis of minimum total cost per unit of transport work is proposed as a general approach to design. Author (TAB)

N70-14518# Oak Ridge National Lab., Tenn.

SPACE HEATING IN URBAN ENVIRONMENTS

A. J. Miller *In* AEC Abundant Nucl. Energy May 1969 p 219 - 237 refs

Avail: CFSTI

A preliminary study indicates that in 1980 the heat from a nuclear energy center in or near a large city could be used to heat and to air-condition a large portion of the city at a cost per unit of heat equivalent to that now incurred by district heating in downtown commerical and high-rise apartment areas. The heat used would be from steam out of back-pressure turbines and turbine

bleed rather than from prime steam, and thus the waste of heat from the plant generating electricity would be reduced or largely eliminated. Such a system would reduce both chemical pollution of the air and thermal pollution of streams. Author (NSA)

N70-14933# Stanford Univ., Calif. Plasma Physics Lab.
EFFECTS OF ELECTRODE SIZE ON THE PERFORMANCE OF A COMBUSTION DRIVEN MHD GENERATOR Technical Report Jul. 1966 - Jul. 1969
Edward Stephen Rubin Aug. 1969 151 p refs
(Contract F33615-67-C-1127)
(AD-694039; AFAPL-TR-69-72) Avail: CFSTI CSCL 10/2

A single molybdenum electrode pair, shielded from end effects by two additional electrode pairs, was located at the downstream end of an MHD channel. Two types of experiments were performed. First, the effects of electrode size on performance was examined at electrode temperatures between 530K and 1600K for a fixed channel geometry, combustion gas mass flow rate, magnetic field strength, and upstream wall temperature (2200K). Three electrode sizes were used (length-to-pitch ratios of 0.2, 0.5, and 0.8), and performance was evaluated directly from electrode voltage drops determined as a function of current. The second type of experiment investigated electrode size effects in the presence of dissimilar boundary layer conductivities, reflecting coupling between electrode and gas boundary layer temperatures in a cold-electrode generator. A hot wall was used upstream of small electrodes and a cold (750K) wall upstream of large electrodes. For similar conditions of surface and gas boundary layer temperature, larger electrodes were found to yield lower voltage losses at a given load current. However, for dissimilar boundary layers, total voltage losses for a large electrode pair were equal to or greater than those of a small electrode pair at the same surface temperature. Author (TAB)

N70-15650# Avco-Everett Research Lab., Everett, Mass.
RESEARCH ON INERT GAS MFD ENERGY CONVERSION Final Report
Jean F. Louis Wright-Patterson AFB, Ohio. ARL May 1969 116 p refs
(Contract AF-33(615)-3413)
(AD-694529; ARL-69-0076) Avail: CFSTI CSCL 10/2

The report contains a discussion of the results of a research program to determine the bulk properties of plasmas in the MFD disk generator driven by a high temperature, large mass flow, alkali shock tunnel. Also, the performance of the MFD disk generator is examined as a promising high Hall coefficient, high power density MFD power generator. Specifically, the study phases are: Theoretical studies of two-temperature plasmas operating at high Hall coefficients; one-dimensional analysis of non-equilibrium flows in a MFD disk generator; theoretical study of the MFD disk generator as a practical power generator; description of the large MFD generator facility; experimental studies of high Hall coefficients in an argon-driven generator; experimental studies of an argon-driven generator with upstream pre-ionization; experimental studies of a nitrogen-driven generator. Author (TAB)

N70-16217# Advisory Group for Aerospace Research and Development, Paris (France).
SPACE POWER SYSTEMS, PART 1 Lecture Series
Nov. 1969 348 p refs Presented at Brussels, 2–6 Oct. 1967
Sponsored by AGARD
(AGARDograph-123-Pt-1) Avail: CFSTI

CONTENTS:

1. SIMILITUDES AND LIMITATIONS IN TRANS-CONVENTIONAL PROPULSION SYSTEMS G. C. Szego (Inst. for Defense Analyses, Arlington, Va.) p 1–19 refs

2. SPACE POWER SYSTEMS G. C. Szego (Inst. for Defense Analyses, Arlington, Va.) p 21 89 refs

3. NUCLEAR SPACE POWER SYSTEMS H. M. Dieckamp p 91–302 refs

4. MECHANICAL HEAT ENGINES FOR SPACE POWER SYSTEMS E. B. Zwick p 303 348 refs

N70-16220# Advisory Group for Aerospace Research and Development, Paris (France).
NUCLEAR SPACE POWER SYSTEMS
H. M. Dieckamp *In its* Space Power Systems, Pt. 1 Nov. 1969 p 91–302 refs
Avail: CFSTI

A general discussion is given of previous nuclear power systems used in space. The nuclear system offers definite advantages of ruggedness, high power per unit area, no collector deployment, continuous power, minimum power storage requirements, and no orientation, factors which limit the use of batteries and other chemical systems. As the power requirements are increased to the order of tens of kilowatts, the nuclear reactor systems have an increasingly favorable weight, size, and cost advantage over any of the presently envisioned solar power systems. The Systems for Nuclear Auxiliary Power program is discussed within the context of increased power requirements to fill future needs. R.B.

N70-16221# Advisory Group for Aerospace Research and Development, Paris (France).
MECHANICAL HEAT ENGINES FOR SPACE POWER SYSTEMS
Eugene B. Zwick *In its* Space Power Systems, Pt. 1 Nov. 1969 p 303–348 refs
Avail: CFSTI

Mechanical Heat Engines represent an important class of energy conversion devices for power generation in space. Power levels ranging from kilowatts to megawatts can in principle be supplied by mechanical systems having high thermal efficiency and low total system weight. The use of mechanical systems is particularly attractive because of a solid foundation of thermodynamic principles and component development. Only materials problems are a significant obstacle in the development of mechanical power systems for space use. The heat engine concepts are reviewed which are of significance for space applications. A thermodynamic consideration is given to establish basic cycle characteristics and the relative importance of various factors such as temperature and component efficiency on cycle performance. A number of cycles are examined in terms of the problem of optimizing a power system for use with a space vehicle. R.B.

N70-16224# Advisory Group for Aerospace Research and Development, Paris (France).
ALTERNATORS FOR SPACE POWER APPLICATIONS
Eugene B. Zwick *In its* Space Power Systems, Pt. 2 Nov. 1969 p 371–396 refs
Avail: CFSTI

Dynamic space power systems normally use alternators as a means of converting mechanical to electrical energy. Direct current machines are usually unsuitable because of problems with brushes and commutators in a severe environment. Electrostatic machines are discussed briefly. Alternators used in missile and space power applications include many of the types already developed for ground power use. Requirements for very high temperatures, corrosive environments, and extremely high rotative speeds have led to innovations in alternator design. The new machinery which has been developed shows considerable promise for future application in both space and terrestrial use. Author

N70-18226# Advisory Group for Aerospace Research and Development, Paris (France).
ENGINEERING ASPECTS OF THERMIONIC ENERGY CONVERSION
Ned S. Rasor *In its* Space Power Systems, Pt. 2 Nov. 1969 p 415-441 refs
Avail: CFSTI

The status of thermionic converter development is outlined from the viewpoint of prospective engineering use. The research upon which the description is based is reviewed elsewhere. Also, a perspective of recent trends is taken in describing progress toward practical application, rather than a review of past work. Special attention is given the broadening spectrum of new approaches which have arisen in response to changes in requirements, especially when viewed on an international scale. The engineering utility of the present understanding, and the potential impact of research in progress, is illustrated by specific examples of their application in these new approaches. Author

N70-18227*# National Aeronautics and Space Administration, Washington, D.C.
ELECTROCHEMICAL SPACE POWER SOURCES
Ernst M. Cohn *In* AGARD Space Power Systems, Pt. 2 Nov. 1969 p 443-501 refs
Avail: CFSTI CSCL 10B

Because of the convenience, efficiency, and simplicity of chemical energy storage combined with electrochemical production of electricity, galvanic batteries powered the first airborne and the first spaceborne on-board electrical systems. After a general discussion of electrochemical energy storage and electricity generation in space, the paper presents the thermodynamic and kinetic electrochemical basis for these devices, as well as criteria for selecting electrochemically active materials and estimating densities. The following three sections cover primary (single use) and secondary (rechargeable) equipment, either now being used or of potential usefulness in space. The last two sections relate some design criteria for space power systems and consider possible earth-bound applications of space-oriented electrochemical research and development. Author

N70-17651*# Florida Univ., Gainesville. Dept. of Nuclear Engineering Sciences.
TRANSACTIONS OF THE SYMPOSIUM ON RESEARCH ON URANIUM PLASMAS AND THEIR TECHNOLOGICAL APPLICATION, 7-10 JANUARY 1970
1970 103 p refs
(Grant NGL-10-005-088)
(NASA-CR-107857) Avail: CFSTI CSCL 18I

A total of 37 abstracts or long summaries of symposium papers are presented under the following main headings: concepts; containment, flow, and stability; properties of uranium plasmas; nucleonics and radiation; nuclear light bulb engine ; MHD power generator; and nuclear lasers. Four other papers are treated in greater detail: (1) acoustic instability driven by absorption of radiation in gases, (2) gas-core nuclear rocket concept with fuel separation by MHD driven rotation, (3) thermal radiation absorption processes in gas core reactors, and (4) gas-core reactors for MHD power systems. D.L.G.

N70-18341# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
PHYSICAL AND TECHNICAL PROBLEMS OF DIRECT CONVERSION OF CHEMICAL ENERGY INTO ELECTRICAL
N. S. Lidorenko et al 25 Apr. 1969 22 p Transl. into ENGLISH from Akad. Nauk SSSR, Izv. Energ. i Transp. (USSR), no. 4, 1968 p 3-12
(AD-696497; FTD-MT-24-39-69) Avail: CFSTI CSCL 10/2

An analysis is made of the basic power aspects of the problem of developing fuel cells. From a physical energy point of view the system of electrochemical generators (ECG) is examined on the basis of an analysis of three components-the ECG itself and the systems of accessories and automatic adjustment, the creation of which is combined with the solving of a number of specific problems. The most important of these problems are examined and the necessity of their overall solution is brought out. As an example of practical realization of these problems, data are cited for an electrochemical generator with polymeric hydrophobic electrodes. This generator has promise for application in ground transport equipment. An analysis is made of the technology of manufacture of electrodes, design of battery, and volt-ampere characteristics. Photographs are shown of a Soviet ECG with ion-exchange membranes and cermet electrodes. Author (TAB)

N70-18728*# National Aeronautics and Space Administration, Washington, D.C.
CLOSED-CYCLE MAGNETOGASDYNAMIC POWER GENERATION
Lester D. Nichols *In its* Plasmas and Magnetic Fields in Propulsion and Power Res. 1970 p 65-84 refs
Avail: CFSTI CSCL 20I

The principles of operation in magnetohydrodynamic (MHD) generators are investigated. One of the advantages of an MHD system is that it is considered simpler than turboalternators because of the lack of seals, bearings, and auxiliary equipment associated with rotating machinery. Discussed are the types of generators, both open and closed thermodynamic cycle: generator current-voltage characteristics; electron heating, effect of fluctuations, effect of impurities, and space power systems study. F.O.S.

N70-18729*# National Aeronautics and Space Administration, Washington, D.C.
PLASMA HEATING AND CONTAINMENT
Warren D. Rayle, John J. Reinmann, J. Reece Roth, and Donald R. Sigman *In its* Plasmas and Magnetic Fields in Propulsion and Power Res. 1970 p 85-122 refs
Avail: CFSTI CSCL 20I

The possibility of controlled thermonuclear fusion for space power and propulsion was studied. The required parameters for deuterium-tritium, or deuterium- helium-3 are shown as: temperature, 10 to the 8th power to 10 to the 10th power K; confinement time, 0.1 to 1.0 sec; density, particle/cubic meter, 10 to the 20th power to 10 to the 22nd power; magnetic field, T, 5 to 10. The major fusion research problems are considered to be plasma confinement, and plasma production and heating. The problems of plasma instability and ion heating are discussed. F.O.S.

N70-19190*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.
EXPERIMENTAL PERFORMANCE OF A 2-15 KILOWATT BRAYTON POWER SYSTEM IN THE SPACE POWER FACILITY USING KRYPTON
David B. Fenn, James N. Deyo, Thomas J. Miller, and Richard W. Vernon Jan. 1970 35 p refs
(NASA-TM-X-52750) Avail: CFSTI CSCL 10A

A Brayton power system has been operated in a vacuum environment for 584 hours using krypton as the working gas. This investigation was the first operation of the complete Brayton power system. With the exception of the heat source and the heat sink (no radiator was used), the engine components represented flight-type hardware. The engine produced 9.2 kilowatts gross alternator power (7.8 kW estimated net engine power), a gross engine efficiency of 26 percent, and an estimated net engine efficiency of 22 percent at a turbine inlet temperature of 1400 F, a compressor discharge pressure of 44 psia, and a compressor inlet temperature of 80 F. Author

N70-19359# Sandia Corp., Albuquerque, N.Mex.
SNAP-19 RESIDUAL FIRE TEST
R. E. Berry Aug. 1969 63 p refs
(SC-DR-69-490) Avail: CFSTI

Two residual fire tests were performed on SNAP-19 test items to evaluate the response of the test items to a 30 minute JP-4 fire environment which produces a temperature of about 1850 F at 24 inches above the liquid level. The first test included only a SNAP-19 Dispersion System Generator. The second test included four test items, and each test item was positioned to provide specific fire information on that item. The items were: a Dispersion System Generator; a Dispersion System Capsule; an Intact Reentry Heat Source Generator System; and an Intact Reentry Heat Source Capsule. Author (NSA)

N70-19953# Oak Ridge National Lab., Tenn.
STABILITY OF TOKAMAKS
Edward G. Harris 16 Oct. 1969 21 p refs Sponsored by AEC
(ORNL-TM-2766) Avail: CFSTI

Following a conjecture by Morse and Freidberg, the stability of the Bennett pinch was investigated with a magnetic field parallel to the axis. Under certain conditions all instabilities may be eliminated except for localized MHD instabilities near the axis. According to a modified form of the Suydam criterion derived, the MHD instabilities are eliminated when the cylindrical Bennett pinch is bent into a torus and the toroidal beta is less than (5/4) (r sub o/R) to the 2nd power, where r sub o is the mean radius of the pinch and R is the major radius of the torus. It is suggested that Tokamaks may operate in this stable regime. Author (NSA)

N70-21100 National Lending Library for Science and Technology, Boston Spa (England).
INVESTIGATIONS INTO THE DYNAMICS OF A NUCLEAR CLOSED-CYCLE GAS TURBINE PLANT WITH HIGH TEMPERATURE REACTOR
K. D. Kueper 17 Dec. 1969 20 p refs Transl. into ENGLISH from Proceedings of the IFAC Symp. on Multivariate Control Systems, Duesseldorf, 7 - 8 Oct. 1968
(NLL-WH-Trans-271-(9091.9F)) Avail: Natl. Lending Library, Boston Spa, Engl.: 2 NLL photocopy coupons

A calculation model is described which was used to investigate the dynamic behavior of the nuclear power plant. Systems of equations are used to describe the plant operations and include models of the reactor, heat exchanger, and circuit. It is concluded that the plant can respond very quickly to changes in power requirements without essentially changing the reactor temperatures or the occurrence of instabilities in the circuit. D.L.G.

N70-21253# Army Electronics Command, Fort Monmouth, N.J.
PROCEEDINGS OF THE ANNUAL POWER SOURCES CONFERENCE, 20-22 MAY 1969
1969 186 p refs
(AD-696428) Avail: CFSTI CSCL 10/3

Topics included are: Fuel cells; Power processing; Primary batteries; Zinc-air batteries; Secondary batteries; Fuze power sources; Thermal energy conversion. TAB

N70-21895# Institut fur Plasmaphysik G.m.b.H., Garching (West Germany).
CALCULATION OF GAS PARAMETERS IN MHD GENERATORS [BERECHNUNG DER GASPARAMETER IN MHD-GENERATOREN]
H. Zinko Jun. 1969 26 p refs In GERMAN; ENGLISH summary
(IPP-3/97) Avail: CFSTI

The variation of the gas parameters in ideal MHD generators with infinite electrode segmentation can be described by simple analytic relations if the current density, load factor, and magnetic field are kept constant. The magnetoplasmadynamic equations derived under these conditions for three types of ducts (constant area, constant velocity, and constant Mach number) were applied by means of numerical computation to alkali rare gas mixtures with nonequilibrium conductivity. In this way, gas parameters such as pressure, temperature, density, and velocity, and electrical data such as current density, power density, and electrical conductivity were plotted as functions of the duct length. The properties and efficiency of the various types of ducts are discussed and compared. As an example of application, the efficiency and magnetic field strength are calculated as functions of the load factor and Mach number for MHD generator with a thermal power of 100 megawatt. Author (ESRO)

N70-22218 Purdue Univ., Lafayette, Ind.
LIFETIME CONSIDERATION AND ECONOMIC EVALUATION OF A LARGE, FAST, BREEDER, MIXED FUEL CYCLE SYSTEM
Ivan Dale Green (Ph.D. Thesis) 1968 253 p
Avail: Univ. Microfilms: HC $11.50/Microfilm $3.00 Order No. 69-7449

The object of this work was to investigate the effect of fuel depletion in conjunction with the sodium void coefficient and to make an economic evaluation of a particular mixed fuel cycle design. In order to make a meaningful investigation and economic evaluation, a similar all plutonium reference fuel cycle design was chosen, and its lifetime and economic effects, calculated using identical methods, were compared to the mixed fuel cycle design. The net outcome was that the mixed system had a 16 percent lower total core sodium void coefficient at the beginning of core life. The sodium void coefficient of the mixed system, in the central core zone where the reference system has its largest void coefficient, was 60 percent lower than that of the reference system. As the higher isotopes build up, the sodium void coefficients of both systems decreased. The decrease was faster for the mixed system, for at the end of core life its total core sodium void coefficient was 50 percent lower than that of the reference system. Dissert. Abstr.

N70-22247# Kernforschungszentrum, Karlsruhe (West Germany). Inst. fuer Reaktorbauelemente.
ROD HEATERS WITH INDIRECT RESISTANCE HEATING FOR SIMULATION OF NUCLEAR FUEL RODS [HEIZSTAEBE MIT INDIREKTER WIDERSTANDSBENEIZUNG ZUR SIMULIERUNG VON KERNBRENNSTAEBEN]
V. Casal Mar. 1969 28 p refs In GERMAN
(KFK-894) Avail: AEC Depository Libraries

High load indirectly-heated heating rods were developed, instrumented, and tested for the simulation of nuclear fuel rods. They have the dimensions of the fuel rods of fast breeder reactors and exhibit at least the reactor rod output at the maximum cladding temperatures. With these instrumented rods, studies were made of the heat transfer of the fuel elements in air, steam, and water flows. The studies showed that the MgO insulated rods at surface tempratures of 700 C reach rod outputs of 300 W/cm. This can be increased in BN insulated rods at the same temperature to around 900 W/cm. Author (NSA)

N70-22307# United Kingdom Atomic Energy Authority, Risley (England).
EQUICORE: A SPACE DEPENDENT CODE TO ASSESS THE NUCLEAR AND THERMAL PERFORMANCE OF SGHW AND SIMILAR REACTORS
A. Bicevskis and E. W. Hesse 1969 33 p refs
(TRG-1808) Avail: CFSTI

EQUICORE is a survey code written in Fortran 4 which deals with a pressure tube reactor core at equilibrium and calculates both the fuel burnup and the average RZ-power distribution with the corresponding channel coolant conditions across the core. The EQUICORE method calculates the flux field from the average

properties in the core which are obtained from hydraulic and burn-up calculations in representative channels across the core, the calculating sequence proceeding in an iterative manner. Since time dependence was eliminated and a realistic core representation was achieved in two dimensions the calculation is fast and the method is suitable for investigating many alternative designs and fuel management schemes. In addition the code has the facility for calculating the variation of power and flow during a time dependent burnup of a central channel surrounded by the previously determined equilibrium core properties. The EQUICORE code is at present fully operational and was used during a design study to investigate a range of core parameters. Author (NSA)

N70-22862*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
SPACECRAFT POWER
In its Space Programs Sum. No. 37-59, Vol. 3 31 Oct. 1969 p 90-127 refs
Copyright. Avail: CFSTI CSCL 10B

Examined are the following aspects of spacecraft power: (1) lightweight solar panels in combination with NiCd batteries for tracking and data relay satellite network; (2) design of heat sterilizable silver oxide-zinc battery; (3) heat generation measurements for Surveyor main battery by isothermal calorimeter with automatic read-out; (4) gravity effects on zinc electrode performance; (5) surface reactions during oxidation and reduction of alkaline silver electrode; (6) simulation of gamma ray spectrum and intensity from plutonium -238 source; (7) schielding requirements for radiation field around plutonium-236 source; (8) development of cylindrical thermionic energy converters operating on heat release from isotopic decay; (9) life endurance tests of lead-telluride multi-couple thermoelectric modules; (10) development of long life high-performance silver oxide-zinc battery; and (11) operational features and capabilities of radioisotope thermoelectric generator test laboratory. G.G.

N70-23985# Army Electronics Command, Fort Monmouth, N.J.
ULTRA-RELIABLE POWER PROCESSOR FOR HYDROCARBON-AIR FUEL CELL POWER SYSTEMS
Melvyn S. Kosmin Nov. 1969 26 p refs
(AD-699311; ECOM-3197) Avail: CFSTI CSCL 10/2

A 50 ampere power processor for shelter mounted hydrocarbon-air fuel cell power systems is described. The processor converts raw fuel cell power to the precise, high quality power required by military communications-electronic equipment. It is characterized by high efficiency (greater than 90%), high reliability (10,000 hours MTBF), and light weight, accomplished through the use of advanced high frequency, current controlled, switch modulation techniques. Automatic protection of the fuel cell against overloads, reverse current, and undervoltage operation is provided. A unique function of the processor is that it optimally loads the fuel cell to aid in system bootstrapping for faster start-up. Current limiting allows parallel operation when higher power levels are required and provides a battery charging capability. Interface compatibility with the fuel cell, battery and load, and ancillary items are also discussed. Author (TAB)

N70-24132# Avco-Everett Research Lab., Everett, Mass.
COMPARISON OF EXPERIMENTAL AND ANALYTICAL RESULTS FOR A 20 MW COMBUSTION-DRIVEN HALL CONFIGURATION MHD GENERATOR
O. K. Sonju, J. Teno, and T. R. Brogan Nov. 1969 26 p refs
(RR-344) Avail: CFSTI

The results of a continuing effort to upgrade "design" and "off design" analytical techniques for MHD generators are reported. The analytical techniques are applicable to all types of generators, but the work reported is primarily concerned with the analysis of Hall MHD generators. The analytical techniques used in the analysis including boundary layer analysis, gas nonuniformity considerations, and electrode drop effects, are reviewed. As a check on the analysis, comparisons between predicted and observed operating parameters of a 20 MW Hall generator are made. Although some small discrepancies still exist, the correlation between predicted and observed performance is very good. The analysis is shown to predict the maximum loading (stalling point) of Hall generators accurately. Based on the conclusion that the analysis is quite accurate in view of the comparisons and checks made, it is felt that these analytical techniques can be used with some confidence to design and predict the performance of future MHD generators with a high degree of accuracy. Author

N70-25446*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
NUCLEAR POWER FOR MANNED ORBITING SPACE STATIONS
H. O. Slone and L. I Shure 1970 17 p refs Presented at the Conf. on Aerospace Nucl. Appl., Huntsville, Ala., 28-30 Apr. 1970
(NASA-TM-X-52774) Avail: CFSTI CSCL 18E

The impact of using nuclear (reactor and isotope) power systems on space stations and space bases is discussed, and candidate nuclear power systems are compared. Much of the information presented is derived from the current NASA Phase-B space station studies. Author

N70-25577# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
PLASMA PHYSICS AND PROBLEMS OF MAGNETOHYDRODYNAMICS IN THE TRANSFORMATION OF ENERGY
M. D. Millionshchikov 2 Oct. 1969 28 p refs Transl. into ENGLISH from Oktyabr i Nauchnyi (Moscow), 1967 p 217-236
(AD-699661; FTD-MT-24-154-69) Avail: CFSTI CSCL 10/2

Progress being made in creating magnetohydrodynamic generators in the Soviet Union is described. The article opens with a general discussion of the problems encountered in transforming the energy contained in chemical fuels into electrical energy. Efforts to overcome these problems have led to magnetohydromagnetic generators in which current is caused to flow in liquid, gas (plasma), or gas-liquid conductors moving through a magnetic field. Implementation of this principle has become possible in recent years due to development of good liquid and gas conductors, new heat-resistant materials, high temperature technology, the technology of superstrong magnetic fields, and large superconducting magnetic systems. Author (TAB)

N70-25623*# Ampex Corp., Redwood City, Calif.
DESIGN, FABRICATION AND TESTING OF A FOIL GAS-BEARING TEST RIG
L. Licht Washington NASA May 1970 78 p refs
(Contract NAS3-11826)
(NASA-CR-1563; RR-69-9) Avail: CFSTI CSCL 13I

A sixteen-inch long rotor, weighing approximately twenty one pounds, was supported by air-lubricated foil bearings. In physical size and in mass distribution, the rotor was closely matched with that of an experimental Brayton cycle turboalternator unit. The rotor was stable in both the vertical and horizontal attitudes at speeds up to and in excess of 48,000 rpm. A detailed description of the experimental apparatus and of the foil bearing design are given. The report contains data of response of the rotor to rotating imbalance, symmetric and asymmetric, and to excitation by means of a vibrator (shake-table). It was demonstrated that the foil bearings accommodated thermal distortions and performed satisfactorily in the presence of appreciable temperature gradients along the journal. It is concluded that the gas-lubricated foil bearing suspension is stable and that it is endowed with superior distortionconforming and wear characteristics. Author

N70-25646# Oak Ridge National Lab., Tenn.
A STUDY OF METALLIC URANIUM FUELED PRESSURIZED WATER REACTORS FOR THE PRODUCTION OF PROCESS HEAT OR ELECTRIC POWER
Truman D. Anderson, J. E. Jones, Jr., and C. M. Podeweltz Dec. 1969 237 p refs
(Contract W-7405-eng-26)
(ORNL-TM-2451) Avail: CFSTI

An investigation was made of the applicability of metallic uranium fuels to pressurized-water reactors. Both process-heat and power reactors were considered, but the primary emphasis was on process-heat reactors suitable for single-purpose desalting. The results indicate that the use of metal fuel may lead to the development of an advanced converter that retains most of the system technology of present light-water reactors. Conversion ratios of about 0.9 were obtained for both process-heat and power reactors. The high conversion ratios achievable with metal fuel could lead to reduced fuel-cycle costs and better utilization of ore resources and diffusion plant capacity. Several uncertainties must be resolved before metal fuel could become commercially useful. The most important of these uncertainties concerns the corrosion of uranium metal in water. Author (NSA)

N70-26116*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
HIGH VOLTAGE GENERATION WITH A BETA ELECTROGENERATOR CELL
Charles A. Low, Jr. [1970] 26 p refs Proposed for presentation at 5th Intersoc. Energy Conversion Eng. Conf., ENERGY-70, Las Vegas, Nev. 21 Sep. 1970
(NASA-TM-X-52776) Avail: CFSTI CSCL 18N

The direct conversion of the radioactive decay energy of a beta emitter, cerium-144, into high voltage electricity has been investigated in a coaxial cylinder cell. A 100 curie beta source absorbed in a thin graphite band on a 28 centimeter inner cylinder constituted the energy source. The energy spectrum and the output voltage were measured with a semiconductor detector. At high vacuums the maximum voltage was limited to 50 to 75 kilovolts, even when the electrodes were preconditioned to a higher voltage. Introduction of argon at pressures near .0005 torr increased this voltage capability to about 200 kilovolts. Author

N70-26208# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Stuttgart (West Germany). Inst. fuer Energiewandlung und Elektrische Antriebe.
MAGNETOPLASMADYNAMIC (MPD-) CONVERTERS [MAGNETOPLASMADYNAMISCHE (MPD-) WANDLER]
Walter Peschka, Horst Eitel, and Wilfried Seeger Nov. 1969 88 p refs In GERMAN; ENGLISH summary
(DLR-FB-69-85) Avail: CFSTI

Theoretical and experimental results on closed cycle inductive MPD-systems are given. Mercury vapor and argon were used as working fluids and high frequency discharges generated the plasma. Cryopumping systems were successfully used in the experiments. Some ideas for the further development of the experimental work are also given. Author (ESRO)

N70-26388 National Lending Library for Science and Technology, Boston Spa (England).
COMPARISON OF THE ECONOMICS OF REPROCESSING BY DRY AND WET METHODS IN THE FRAMEWORK OF THE FUEL CYCLE OF BREEDER REACTORS
L. Thirlet 1969 22 p refs Transl. into ENGLISH from Energie Nucl. (Paris), v. 11, no. 5, Jul. 1969 p 298
(NLL-WINDSCALE-Trans-414-(9091.()) Avail: Natl. Lending Library, Boston Spa, Engl.: .2 NLL photocopy coupons

In the example selected for the wet method, the solution of constructing a factory on one site alone is optimum with the selected data and remains so when the rate of realization, factory lifetime, and beginning of reduction in investment costs are changed. When the cost related to factor operation increases, the solution of constructing a factory on a second site without curtailing operation of the first becomes optimal. If transport costs increase, the solution of division of materials to reprocess between two factories after construction of a first factory of modest size becomes optimal. Satisfying an expanding demand generally requires consideration of the effects of size by which industrial plants profit. The results described cover the limited geographic region of France, but it is concluded that the methods are suitable over a wider area. R.B.

N70-26434# Rasor (Ned S.), Dayton, Ohio.
PRACTICAL ASPECTS OF FUNDAMENTAL RESEARCH IN THERMIONIC CONVERSION Final Technical Report, 1 Mar. - 1 Sep. 1969
Ned S. Rasor Dec. 1969 67 p refs
(Contract N00014-69-C-0279)
(AD-699944; NSR-1-1) Avail: CFSTI CSCL 10/2

The report summarizes a study of factors in basic thermionic converter research which are potentially important to the success of the engineering programs. An elementary phenomenology-based analytical description of cesium diode converter operation is formulated to serve as an intuitive bridge between the device engineering and physical electronic technologies. The theoretical description of the emission properties of surfaces immersed in cesium vapor is generalized and extended to explain effects of additives and impurities which have been poorly understood. Thermionic emission of negative cesium ions from the collector is explored as a possible mechanism causing anomalous effects at the collector. A synopsis of the interrelation of basic converter physics and thermionic reactor design is developed which indicates that substantial engineering advances are achievable primarily through reduction of electron energy losses in the converter. Author (TAB)

N70-26947# North American Rockwell Corp., Canoga Park, Calif. Atomics International Div.
BASIC RESEARCH IN THERMIONIC ENERGY CONVERSION Technical Summary Report, 1 Aug. 1968 - 30 Nov. 1969
Charles Warner and Lorin K. Hansen Dec. 1969 102 p refs
(Contract Nonr-3192(00))
(AD-700945; AI-69-112) Avail: CFSTI CSCL 10/2

The program was directed toward an understanding of the fundamental processes occurring in thermionic energy converters and the effects of these processes on overall converter performance. A theoretical approach was studied for solving the equations which describe the wide spaced diode. In the past these equations have not been solvable with available techniques. With some reservations the new computer results agree with available experimental data. Secondly, the trapping of ions in potential wells was studied and a new criterion has been developed which relates parameters associated with double sheath emission barriers. This criterion will be useful in deciding the essential physics of converters operating below the knee of the I-V curve. Author (TAB)

N70-28078# Joint Publications Research Service, Washington, D.C.
RESEARCH IN MAGNETOHYDRODYNAMICS SUMMARIZED
Andrei Nicolaide *In* Transl. on Eastern Europe Sci. Affairs, No. 102 4 Mar. 1970 p 9-11 Transl. into ENGLISH from Scinteia (Bucharest), 14 Jan. 1970 p 6
Avail: CFSTI

Magnetohydrodynamic pumps and generator concepts are briefly discussed, as well as research in the theoretical and practical development of MHD pumps and flowmeters. S.S.

N70-28433*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
DESCRIPTION AND EVALUATION OF DIGITAL-COMPUTER PROGRAM FOR ANALYSIS OF STATIONARY OUTSIDE COIL LUNDELL ALTERNATORS
Gary Bollenbacher Washington Jun. 1970 119 p refs
(NASA-TN-D-5814) Avail: CFSTI CSCL 10B

A digital computer program for analyzing the electromagnetic design of Lundell alternators is presented. The program, which is written in FORTRAN 4 programming language, is briefly described. The calculational methods are outlined or appropriate references are cited. Calculated results for a 14.3-kVA alternator are compared with experimental data. The comparison identifies two sources of error in the program: the rotor leakage permeance, which affects the field excitation calculation; and the no load pole-face loss, which, if large compared to other losses, affects the accuracy of the efficiency calculation. Despite these sources of error, the agreement between calculated and experimental data is reasonable, and the program is useful for parametric analysis and design optimization. Author

N70-29012# Florida Univ., Gainesville. Dept. of Nuclear Engineering Sciences.
DEVELOPMENT OF PLASMA DIAGNOSTIC METHODS APPLICABLE TO DIRECT ENERGY CONVERSION, SUMMARY Final Technical Report
Richard T. Schneider 1 Jan. 1970 29 p refs
(Contract Nonr-580(19))
(AD-702405) Avail: CFSTI CSCL 20/9

Contents: Time resolved diagnostics of a pulsed low pressure discharge; Pulsed electrodeless discharge in hydrogen; and a new approach for detecting of low photon fluxes in scattering experiments. TAB

N70-29169*# Illinois Univ., Chicago.
MAGNETOHYDRODYNAMIC INDUCTION GENERATOR EXPERIMENTAL STUDY Final Technical Report
15 Apr. 1970 45 p refs Prepared for JPL
(Contracts NAS7-100; JPL-952453)
(NASA-CR-110154) Avail: CFSTI CSCL 10B

The results of an experimental study of a one-wavelength MHD induction generator operating on a liquid flow are presented. The design philosophy and the experimental generator design are briefly summarized, including a description of the flow loop and instrumentation. The measurements without the fluid or fluid channel are given followed by the results obtained for the fluid flow without the magnetic field. Various generator test results are presented, including normal operation when excited from the 60 hertz power line, and operation from the power line with the end coils shorted to reduce magnetic fringing. Both cases were also operated in the self-excited mode with external capacitors to supply the required reactive power. The harmonic content of the terminal voltage was measured, hypothetical accidents simulated, and two-wavelength tests performed. Author

N70-29364# Oak Ridge National Lab., Tenn.
ISOTOPES KILOWATT PROGRAM. TASK 1: CONCEPTUAL DESIGN AND EVALUATION
R. A. Robinson Jan. 1970 333 p refs
(Contract W-7405-eng-26)
(ORNL-TM-2366) Avail: CFSTI

Conceptual designs were prepared for several types of radioisotope electric power systems in order to determine which types of systems show the most promise for early development for terrestrial and undersea applications in the 2 kW(e) to 10 kW(e) power range.. Strontium-90 titanate and Co-60 are considered as potential radioisotope fuels for the systems. The present development status of various energy conversion system components is reviewed. Author (NSA)

N70-29518# Navy Space Systems Activity, Los Angeles, Calif.
SPACE ELECTRICAL POWER SYSTEMS FOR THE MID-1970'S Final Technical Report
Richard V. Silverman Sep. 1969 125 p refs
(AD-701352; NSSA-R40-69-4) Avail: CFSTI CSCL 10/2

An evaluation of candidate electrical power systems capable of providing up to 6.5 kW for an earth orbiting mission is presented in this report. Three power systems could be ready for a mid-1970 launch, if proper funding were provided for development programs. They are: a Solar Cell/Battery System; a Reactor/Thermoelectric System; and a Reactor/Organic Rankine System. The preferred system for the proposed mission is the Reactor/Thermoelectric system, based on its inherent simplicity, lower weight, lower unit costs, and high degree of technology readiness relative to the competing systems. Author (TAB)

N70-29729*# Pratt and Whitney Aircraft, East Hartford, Conn.
RESEARCH ON THE PROPERTIES OF BINARY LIQUID METAL SYSTEMS WITH LITHIUM AS ONE COMPONENT: THE ELECTRICAL RESISTIVITY OF LIQUID LITHIUM SATURATED WITH CESIUM Final Report
F. F. Felber, Jr., S. M. Kapelner, and K. A. Helgeson 13 Feb. 1970 37 p refs Prepared for JPL
(Contract NAS7-658)
(NASA-CR-110370; PWA-3877) Avail: CFSTI CSCL 11F

The electrical resistivity of a saturated solution of cesium in liquid lithium has been measured in the temperature range from 770C to 1100 C by a high precision potentiometric technique and compared with the electrical resistivity of the same sample of liquid lithium measured independently in the same container. Matthiessen's rule is obeyed to approximately 900 C confirming the low solubility of cesium in liquid lithium. The impurity atom resistivity of cesium is less than one microhm-centimeter over this range, increasing to three microhm-centimeters at 1094 C. The temperature dependence of the electrical resistivity of a saturated solution of cesium in lithium can be expressed by the following equation: rho = 41.97 −0.01585t + .00002271t sq where rho is the electrical resistivity in microhm-centimeters and t is in degrees Centigrade. The electrical resistivity of the liquid lithium as a function of temperature in the temperature range 365 C to 973 C is: rho = 21.48 +0.03170t −.000005913t sq. These results indicate that cesium solubility would not significantly alter the generator efficiency with liquid lithium as the conducting fluid in a lithium-cesium, two-component, two-cycle liquid metal MHD generator. Author

N70-29864*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
STARTUP TESTING OF THE SNAP-8 POWER CONVERSION SYSTEM
Herbert G. Hurrell, Fred Boecker, Jr., and Kent S. Jefferies [1970] 14 p refs
(NASA-TM-X-52822) Avail: CFSTI CSCL 18N

SNAP-8 development has included extensive startup testing of the power conversion system coupled with a reactor simulator. Data are presented that show the power conversion system can be started in a dependable way. The temperature transients are well within the limits specified for the reactor. Procedures are discussed for the relatively fast transient to self-sustained operation and for the more gradual transient that achieves rated power output. Author

N70-30407# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Inst. fuer Elektrische Antriebe und Energieversorgung.
POSSIBLE SPACE APPLICATION OF NUCLEAR POWER SUPPLY, PARTICULARLY FOR DIRECT TV-BROADCASTING [EINSATZMOEGLICHKEITEN EINER NUKLEAREN ENERGIEVERSORGUNGSANLAGE IN DER RAUMFAHRT,

INSBES ONDERE FUER DIE FERNSEHDIREKTUEBERTRAGUNG]
W. Rasch, W. Kleinkauf, U. Krupstedt, A. Quast, and W. Scharf
Apr. 1970 393 p refs In GERMAN; ENGLISH summary
Sponsored by Bundesmin. fuer Bildung und Wiss.
(BMBW-FB-W-70-16) Avail: CFSTI; Zentralstelle fuer Luft Fahrtdokumentation und Inform. (ZLDI), Munich: 82 DM

Space application of an Incore-Thermionic-Reactor (ITR) is demonstrated by a direct broadcasting satellite. The electric power of the reactor (30 kW) is applied to the transmission of two TV-programs in the 800 MHz range using vestigial sideband modulation (5 kW transmission power for Central Europe). In addition, a 12 GHz broadcast is discussed. During the orbit transfer, the reactor supplies four Kaufman ion thrustors. The main components of the satellite, (power supply with a advanced cooling system, low voltage converter, electric propulsion system, and TV-payload) are described. Author (ESRO)

N70-31239# Atomics International, Canoga Park, Calif. Liquid Metal Engineering Center.
FAILURE DATA HANDBOOK FOR NUCLEAR POWER FACILITIES. A GUIDE FOR THE DESIGN, CONSTRUCTION, AND MAINTENANCE OF NUCLEAR POWER PLANTS FROM A RELIABILITY IMPROVEMENT STANDPOINT. VOLUME 1: FAILURE DATA AND APPLICATIONS TECHNOLOGY
15 Aug. 1969 735 p
(Contract AT(04-3)-700)
(LMEC-Memo-69-7-Vol-1) Avail: HC$10.00/MF$0.65

Records on past unscheduled events with systems and components in liquid metal cooled facilities are presented. The events relate to construction schedule or cost, safety, availability, or maintainability of a nuclear power plant or test facility. Broad topics include: failures occurring during facility operation; adverse events occurring prior to startup; reliability and availability analysis; and maintainability. NSA

N70-31285# Institut fur Plasmaphysik G.m.b.H., Garching (West Germany).
MEASUREMENTS OF THE POTENTIAL AND CURRENT DENSITY DISTRIBUTIONS IN A SIMULATED FARADAY-TYPE MHD GENERATOR WORKING WITH ARGON-POTASSIUM PLASMA [MESSUNGEN DER POTENTIAL- UND STROMDICHTEVERTEILUNGEN IM ARGON-KALIUM-PLASMA EINES SIMULIERTEN FARADAY-MHD-GENERATORS]
J. Burger Dec. 1969 75 p refs In GERMAN; ENGLISH summary
(IPP-3/104) Avail: CFSTI

Potential distributions in a Faraday-type MHD-generator were measured with movable electrostatic probes in the generator duct to provide data on the relevant current distributions. The current lines and also the regions in which the current of the individual electrode pairs flowed were also determined. The measurements were made in a potassium seeded argon plasma with gas temperature 2000 K, gas pressure 1 atm and flow velocities of 55 - 115 m/sec. The maximum magnetic field intensity was 1.5 tesla and the average current density was 0.1 - 1.7 amp/sq cm. ESRO

N70-31812# Atomics International, Canoga Park, Calif. Liquid Metal Engineering Center.
FAILURE DATA HANDBOOK FOR NUCLEAR POWER FACILITIES. A GUIDE FOR THE DESIGN, CONSTRUCTION, AND MAINTENANCE OF NUCLEAR POWER PLANTS FROM A RELIABILITY IMPROVEMENT STANDPOINT. VOLUME 2: FAILURE CATEGORY IDENTIFICATION AND GLOSSARY
20 Jun. 1969 191 p
(Contract AT(04-3)-700)
(LMEC-Memo-69-7-Vol-2) Avail: CFSTI

Records on past unscheduled events with systems and components in liquid metal cooled facilities are presented. The events relate to construction schedule or cost, safety, availability, or maintainability of a nuclear power plant or test facility. Broad topics include: system or component and failure category identification; and glossary. NSA

N70-31999# General Electric Co., Philadelphia, Pa. Space Div.
PERFORMANCE OF A LARGE SCALE NONEQUILIBRIUM MHD GENERATOR WITH RARE GASES
B. Zauderer Feb. 1970 68 p refs
(Contract Nonr-3867(00))
(AD-703314; DOC-70SD4; ONR-TR-14) Avail: CFSTI CSCL 10/2

An experimental study was performed of the operating characteristics of a large linear, supersonic MHD generator. A shock tunnel was used to heat the test gases, which was primarily a 99 percent neon+1 percent xenon mixture, to stagnation pressures of 1 to 5 atmospheres, temperatures of about 3500K, and electron densities on the order of 10 to the 10th power /cc. The test time of 5 milliseconds, which was about 10 times the traversal time of the gas through the generator, was sufficient to produce quasi-steady state conditions in the channel. It was concluded that electrode conduction losses and shock wave formations were the two major factors limiting the efficiency of this generator. Author (TAB)

N70-32771# Technische Univ., Berlin (West Germany). Inst. fuer Kerntechnik.
COMPARATIVE PERFORMANCE ANALYSIS OF LINEAR MPD GENERATORS
Gerhard Bartsch Sep. 1969 181 p refs In GERMAN
(TUBIK-15) Avail: AEC Depository Libraries

Different types of linear MPD generators are compared, considering power, efficiency, and load factors. Besides special operating conditions (i.e., maximum power or maximum efficiency operation) Hall effect, ion slip, and segmentation ratio are taken into account. These conditions are given separately and explicitly in calculations and diagrams. Thus, their influence on value and slope of parameters such as power and efficiency are distinct. Author (NSA)

N70-32778# Tennessee Univ., Tullahoma. Space Inst.
CURRENT DISTRIBUTION OF A SEGMENTED HALL GENERATOR
Y. C. L. Wu and J. F. Martin 13 Apr. 1970 25 p refs Presented at the 11th Symp. on Eng. Aspects of Magnetohydrodyn., Pasadena, Calif., 24-26 Mar. 1970
(Contract F44620-69-C-0031)
(AD-705160; AFOSR-70-1061TR) Avail: CFSTI CSCL 10/2

The paper describes an experimental and theoretical investigation of the current distribution in a segmented Hall generator with conductive side walls and insulating side walls respectively. The cathode emits in the arc mode; whereas the anode is an equi-potential. The current concentrates in the middle portion of the cathode and is very unsteady. The anode portion appears to be steady and the current spreads out somewhat evenly. The external load has little influence on the anode current distribution. In all load conditions, there is about 60% of the current flow into the anode, 15% flows to one side wall and 25% to the other side wall. The potential distribution on the anode side wall is linear and with a maximum potential drop of 40 volts. The cathode side wall appears to be an equi-potential surface. Author (TAB)

N70-32986# Tennessee Univ., Tullahoma. Space Inst.
THE PERFORMANCE OF A FAMILY OF DIAGONAL CONDUCTING WALL MHD OPEN CYCLE GENERATORS
J. B. Dicks, Y. C. L. Wu, L. W. Crawford, J. K. Koester, J. W. Muehlhauser et al 13 Apr. 1970 16 p refs Presented at the 11th Symp. on Eng. Aspects of Magnetohydrodyn., Pasadena, Calif., 24-26 Mar. 1970
(Contract F44620-69-C-0031)
(AD-705159; AFOSR-70-1059TR) Avail: CFSTI CSCL 10/2

Experimental and theoretical studies were made of the performance of a 45 deg diagonal conducting wall generator and a Hall generator of the same physical dimensions. The wall temperature effect is investigated and an arc model is proposed. Aluminum was successfully burned in the combustor. It was found that the coating from burning of aluminum improves the channel performance due to the heating up of the walls. It was found that the fluctuations present in the Hall channel have much higher frequencies than those in the 45 deg DCW channel. The fluctuations grow along the channel in the Hall mode. The presence of the aluminum attenuates the fluctuations. The effect of the low conductivity nonuniformaties in the plasma and the coating of the wall has a very profound effect on the performance of the Hall generator. Author (TAB)

N70-33216# Academy of Sciences (USSR), Moscow. Inst. Atomnoi Energii.
CERTAIN PROBLEMS OF THE EFFICIENCY OF POWER PRODUCTION IN MHD GENERATORS WITH A NONEQUILIBRIUM PLASMA
V. V. Breev, A. V. Gubarev, and V. A. Gurashvili 1968 66 p refs In RUSSIAN
(IAE-1701) Avail: AEC Depository Libraries

There is serious doubt as to the future of such machines with the linear condition (Faraday) sectioned generator most thoroughly studied, since the efficiency of the station does not exceed 40% using currently feasible field inductions of approximately 10 tesla, a reactor pressure of > or = to 500 atm. and a gas temperature of < or = to 2000 K which are the technical limits for the next decade. Even under the most optimistic assumptions (T approximately 2500 K, beta = 10 tesla, a high degree of heat regeneration, absence of thermal losses, etc.) for a reactor pressure of approximately 100 atm, a station efficiency of greater than 50% is achieved for a unit power of the MHD generator of > or = to 3 × 1,000,000 kW. The reason for such low efficiency is that the physical operating principles of the generator envisioned at the present time (ionization of the plasma, etc.) and the electrogasdynamic design of the generator make it impossible to obtain a high efficiency in the energy conversion process itself in the channel. NSA

N70-33335# Institute of Nuclear Research, Warsaw (Poland).
HALL TYPE MHD GENERATORS WITH NONUNIFORM GAS PARAMETERS ALONG THE CHANNEL AXIS
Z. Celinski 1969 39 p refs
(INR-1107) Avail: AEC Depository Libraries

Expressions are derived which enable one to calculate the elctrical parameters of the generator when the gas parameters vary along the generator channel. The comparison between the calculated electrical parameters in the case of uniform and nonuniform gas parameters was also performed. Author (NSA)

N70-33547# Institute of Nuclear Research, Warsaw (Poland).
ELECTRICAL PARAMETERS IN THE FARADAY TYPE MHD GENERATOR WITH NONUNIFORM GAS PROPERTIES IN THE MAGNETIC FIELD DIRECTION
Z. Celinski 1969 76 p refs
(INR-1095) Avail: AEC Depository Libraries

The effects of gas velocity and temperature distributions in the direction of a magnetic field on the electrical parameters of the Faraday-type MHD generator are considered. As gas properties are varying along the z axis, circulating currents are flowing in the cross-sectional area of the channel due to the nonuniform distribution of the gas velocity. These currents induce the Hall circulating currents along the x axis. The ohmic losses due to the circulating currents are independent of the load factor. The maximum point of the efficiency curve versus load factor is shifted to the lower values of the generator loading. The weak Hall fields can be induced in the open circuit conditions of the generator due to the nonuniform distribution of the Hall parameter. A constant channel cross section, no-leakage currents in the walls, a constant magnetic field, as well as constant electrical and gasdynamical parameters along the channel, are assumed. It is also assumed that the distributions of the gas parameters are independent of the load factor. A numerical example is calculated. Author (NSA)

N70-33672# Institute of Nuclear Research, Warsaw (Poland).
ELECTRICAL PARAMETERS IN THE FARADAY-TYPE MHD GENERATOR WITH NONUNIFORM GAS PROPERTIES IN THE ELECTRIC FIELD DIRECTION
Z. Celinski 1969 69 p refs
(INR-1096) Avail: AEC Depository Libraries

The effects of gas velocity and temperature distributions in the direction of an induced electrical field, on the electrical parameters of the Faraday-type MHD generator are considered. As gas properties are varying in the y direction, strong Hall currents are flowing in the x direction. These currents deteriorate the electrical performance of the generator; the A parameter which characterizes this deterioration is determined. The decrease of electrical terminal values may be strong especially is the case when the magnetic induction is high. The parameter A is proportional to B-2 and depends on the distribution functions of the gas conductivity and of the Hall parameter. The distributions of the electrical parameters in the y direction (current density, electrical potential, electrical field) become more non-uniform with the increasing of B. A constant channel cross section, no-leakage currents in the walls, a constant magnetic field, as well as constant electrical and gasdynamical parameters along the channel are assumed. It is also assumed that the distributions of the gas parameters are independent of the load factor. A numerical example is calculated. Author (NSA)

N70-34134* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
ENERGY CONVERSION APPARATUS Patent
James E. Hatch, inventor (to NASA) Issued 24 Aug. 1965 (filed 8 Nov. 1961) 4 p Cl. 310-4
(NASA-Case-XLE-00212; US-Patent-3,202,844;
US-Patent-Appl-SN-151598) Avail: US Patent Office CSCL 10B

A device is described for direct conversion of thermal energy into electrical energy, using crossed electrical and magnetic fields. Conversion is accomplished by heating an electron-emissive plate contained in a spaced relationship to an electron collector plate. Electrons removed from the electron-emissive plate by heating are accelerated towards an accelerator grid by an electric field established between the plates and grid. A shaped magnet provides a unidirectional nonuniform magnetic field at right angles to the electric field causing the electrons to follow noncolliding circular paths between the electron-emissive plate and the collector plate. R.B.

N70-34959# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
MAGNETOHYDRODYNAMIC METHOD OF OBTAINING ELECTRICAL ENERGY

I. Ya. Shipuk et al 30 Mar. 1970 61 p refs Transl. into ENGLISH from the Russian
(AD-705748; FTD-MT-24-445-69) Avail: CFSTI CSCL 10/2

Contents: Ionization instability in the disk channel of an unbalanced MHD generator; On the approximate solution of equations of the boundary layer on walls of an MHD generator; and Variational problems of magnetohydrodynamics. TAB

N70-36136# Committee on Interior and Insular Affairs (U.S. Senate).
MAGNETOHYDRODYNAMICS (MHD): POLLUTION-FREE PRODUCTION OF ELECTRICAL ENERGY FROM LOW-GRADE COAL, PART 2
Washington GPO 1970 120 p refs Hearing before Comm. on Interior and Insular Affairs, 91st Congr., 2d Sess., 23 Feb. 1970
Avail: Subcomm. on Minerals, Mater., and Fuels

N70-36137# Committee on Interior and Insular Affairs (U.S. Senate).
MAGNETOHYDRODYNAMICS (MHD): POLLUTION-FREE PRODUCTION OF ELECTRICAL ENERGY FROM LOW-GRADE COAL
Washington GPO 1970 122 p refs Hearing before Comm. on Interior and Insular Affairs, 91st Congr., 1st Sess., 18 Dec. 1969
Avail: Subcomm. on Minerals, Mater., and Fuels

Congressional hearings are reported on development of magnetohydrodynamic (MHD) generators as future sources of power. The use of MHD generators for production of electrical energy is described as almost pollution-free, requiring small quantities of water without thermally polluting the waters used in the process. The process can also utilize low-grade coal as the basic raw material, thus permitting exploitation of coal resources which are not economically feasible in conventional steam generating plants. See also N70-36136. R.B.

N70-36408# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
INTERNATIONAL SYMPOSIUM ON MAGNETOHYDRODYNAMIC ELECTRICAL POWER
N. M. Maslenniiov et al 22 Sep. 1969 31 p refs Transl. into ENGLISH from the Russian
(AD-703158; FTD-MT-24-150-69) Avail: CFSTI CSCL 10/2

Contents: Experimental investigation of electrical conductivity of a plasma on a model MHG generator; Spectroscopic investigation of an argon-cesium plasma. TAB

N70-36803* Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
TWO-FLUID MAGNETOHYDRODYNAMIC SYSTEM AND METHOD FOR THERMAL-ELECTRIC POWER CONVERSION Patent
David G. Elliott, inventor (to NASA) Issued 24 Nov. 1964 (Filed 25 Jul. 1962) 8 p Cl. 310-11 Sponsored by NASA
(NASA-Case-XNP-00644; US-Patent-3,158,764; US-Patent-Appl-SN-212496) Avail: US Patent Office CSCL 10B

A gas driven jet pump is used to provide high velocity flow of a liquid metal through a magnetic field to generate electrical energy. The liquid metal and gas mixture expands through a nozzle where the liquid metal is immediately separated from the gas and forced to flow as a thin film between two pole pieces which establishes current flow through the liquid. R.B.

N70-36860*# Gulton Industries, Inc., Hawthorne, Calif. Engineered Magnetics Div.
DC POWER SUPPLY ENGINEERED MAGNETICS MODEL EMPS-252 FOR BRAYTON CYCLE POWER CONVERSION SYSTEM Final Report
M. Kruse 27 Aug. 1970 152 p
(Contract NAS3-10936)
(NASA-CR-72529; FR-2390) Avail: CFSTI CSCL 10B

The Brayton dc power supply converts 1200 Hz ac power to positive 28 volt and negative 28 volt dc power for use in the Brayton Space Power System. This supply also includes a positive and a negative 28 volt battery with chargers and control logic that directly supplies dc output power when ac input power is not available for conversion. The measured ac to dc conversion efficiency is 93%. The calculated mean time between failures is approximately 60,000 hours. The theory of operation, electrical and mechanical design drawings, reliability calculations, parts selections, thermal measurements, and test results are presented. Author

N70-37070*# Scientific Translation Service, Santa Barbara, Calif.
DEVELOPMENT OF INSTALLATIONS FOR DIRECT CONVERSION OF HEAT INTO ELECTRICAL ENERGY BY MEANS OF MHD GENERATORS AND OTHER NEW ENERGY DEVICES
In its The Inst. of High Temp. of the USSR Acad. of Sci. The Most Important Results of Sci. Res. in 1969 Aug. 1970 p 45–83 refs
Avail: CFSTI CSCL 10A

Research connected with the development of stationary electrical power plants is reported and includes the following: (1) Investigations were conducted on metallic electrodes of steel and copper and also on ceramic electrodes of silicon carbide and zirconium dioxide. (2) Experimental equipment was built for studying the dynamics of processes adjacent to electrodes and permitting electro-optical detection of spots with time resolutions down to 10 to the minus 8th power sec with simultaneous measurement of charged particle concentration in the cathode region with time resolutions as low as 5 x 10 to the minus 8th power sec. (3) Investigation of the high-current discharge on electrodes covered directly with an additive in the MHD generator channel demonstrated that the intensity of the electrode disintegration process by pinched discharge is reduced by a factor of ten. (4) Thermal efficiency studies were made of the combined open cycle MHD power plants with various methods of achieving the high temperatures of the combustion products. (5) Theoretical and experimental studies of problems connected with the development of liquid metal MHD power plants were conducted. D.L.G.

N70-37638# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
MHD METHODS OF OBTAINING ELECTRICAL ENERGY: ANNOTATION AND PREFACE
V. A. Kirillin et al 2 Apr. 1970 11 p Transl. into ENGLISH from the Russian
(AD-706160; FTD-MT-24-294-69) Avail: CFSTI CSCL 10/2

The document is comprised of an annotation and preface to a book which is a collection of articles whih present results of scientific research on MHD generators in 1966-1967 at leading USSR organizations. The collection contains a description of research results on the first USSR experimental power installation with the U-02 MHD generator; technical economic analysis of future promising power plants with MHD generators; results of research in physics of plasmas and MHD as applied to problems of MHD generators; and results of work on liquid-metal MHD installations. Author (TAB)

N70-37652# Sundstrand Aviation-Rockford, Ill.
ORGANIC RANKINE CYCLE TECHNOLOGY PROGRAM Quarterly Progress Report, 1 Jul. 1969 - 1 Jan. 1970
R. E. Niggemann 15 Mar. 1970 43 p ref
(Contract AT(04-3)-651)
(SAN-651-1186; QPR-14) Avail: CFSTI

The technology necessary to develop an organic Rankine cycle power conversion system capable of long duration operation in a space environment is investigated. The various studies include the working fluid, the bearings, the condensate pump, and the boilers. The performance of the Sunstrand 6 kwe organic Rankine cycle power system was also evaluated. R.B.

N70-37715# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
ON THE PROBLEM OF CONSTRUCTING SUPERCONDUCTING MAGNETIC SYSTEMS FOR MHD-GENERATORS
V. V. Sychev et al 22 Apr. 1970 31 p refs Transl. into ENGLISH from the Russian
(AD-706779; FTD-HT-24-356-69) Avail: CFSTI CSCL 10/2

The direction towards which research and development in superconducting systems is going is reviewed. Nb-Ti alloys are found to dominate development of superconducting cables. The nature of field penetration in nonideal superconductors is shown to present a vexing problem. The actual design and construction of large scale superconducting systems is shown to be in its infancy. The concept of a magnetic pump for generating high currents in superconductors is emphasized. A detailed account is then given of the research going on in the High Temperature Institute. These include special flux linkage solenoid windings and an investigation in the induction of these superconducting solenoids. The detailed characteristics of three 65BY alloy superconducting solenoids are listed with solenoid constants of 0.78, 2.25, and 0.71 kilo-oersteds/amp. A figure compares the experimental and theoretical flux linkage curves of the three solenoids as a function of the nondimensional excitation current. Careful measurements are made of the static and dynamic inductance of each solenoid. The results show the connection between the inductance and the current during the first excitation, without prior history; the relationship between the inductance and the current during the solenoid discharge. Author (TAB)

N70-38631# Air Force Systems Command, WrightPatterson AFB, Ohio. Foreign Technology Div.
MAGNETOHYDRODYNAMICS IN MARINE ENGINEERING
L. G. Vasilev et al 20 Feb. 1970 233 p refs Transl. into ENGLISH from the Russian
(AD-706643; FTD-HT-23-237-69) Avail: CFSTI CSCL 13/10

Contents: The development and current state of magnetohydrodynamics: Magnetohydrodynamic effects; Magnetohydrodynamic meters; Electromagnetic pumps; Magnetohydrodynamic ship propulsion; and Magnetohydrodynamic power units for moving craft use. TAB

N70-38825# Atomic Energy Commission, Washington, D.C. Div. of Technical Information.
PULSED THERMONUCLEAR REACTOR OPERATED WITH LASERS [MIT LASERN BETRIEBENER GEPULSTER THERMONUKLEARER REAKTOR]
Wolfgang Kaiser et al 7 Jan. 1969 12 p Transl. into ENGLISH from German Patent Appl. no. 1900524, 7 Jan. 1969, 12 p
(AEC-tr-7148) Avail: CFSTI

A reactor employing LiD or LiT fuels, using a high power laser beam for excitation, is described. The advantages of the system are discussed. NSA

N70-39141# California Univ., Livermore. Lawrence Radiation Lab.
FUSION POWER: DIRECT CONVERSION AND THE REDUCTION OF WASTE HEAT
R. F. Post [1970] 16 p
(TID-25414) Avail: NTIS

Fusion reactors are discussed in the context of the direct conversion of fusion energy to electricity. The use of particles released from fusion reactors for the purpose of direct conversion is discussed. The use of different fuels and different conversion cycles is also discussed. NSA

N70-39278*# National Aeronautics and Space Administration, Washington, D.C.
HIGH-POWER, LONG-LIFE ELECTRICAL GENERATING SYSTEMS FOR LUNAR BASE MISSIONS
Paul R. Miller *In its* Proc. of the 7th Ann. Working Group on Extraterrest. Resources 1970 p 11-21 refs
22-30)
Avail: SOD $1.50; NTIS CSCL 10B

Nuclear and solar cell systems are potential power system candidates. An updated comparison of the primary performance characteristics of these two system types is presented. The effects of possible lunar base mission constraints and requirements identified from previous studies on these characteristics are then reviewed. Author

N70-40031# General Electric Co., Philadelphia, Pa.
OPTIMIZATION OF A LINEAR NON-EQUILIBRIUM MHD GENERATOR
B. Zauderer Jun. 1970 22 p refs *Its* ONR Tech. Rept. No. 15
(Contract Nonr-3867(00))
(AD-707803; DOC-70SD281) Avail: NTIS CSCL 10/2

Based on the results of an experimental study of a supersonic, non-equilibrium MHD generator, a theoretical optimization of such a generator was performed. It was found that neon seeded with less than 0.1% cesium was the optimum generator working fluid. The maximum generator power output and efficiency was obtained in a constant current density generator operating with a favorable pressure gradient. The optimum channel geometry had an exit to entrance area ratio of about six, linearly diverging channel walls, and a length to average diameter ratio of about ten. It was also shown that a constant velocity generator with a linearly diverging channel geometry had a very low generator conversion efficiency. Author (TAB)

N70-40974*# National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.
FUEL CELL TECHNOLOGY PROGRAM
David Bell *In its* Space Transportation System Technol. Symp., Vol. 6 Jul. 1970 p 349-360
Avail: NTIS CSCL 10B

The advanced fuel cell program to support the primary electrical power requirements of space shuttle vehicles in the mid-1970's is discussed. The objective is to advance the technology of hydrogen-oxygen fuel cells through a rigorous and comprehensive program commencing at the lowest component and material level and progressing through the fabrication and test of an engineering model fuel cell and related components and assemblies. Author

N70-42202*# TRW Equipment Labs., Cleveland, Ohio. Power Systems Dept.
BRAYTON CYCLE CAVITY RECEIVER DESIGN STUDY
22 Nov. 1965 325 p refs

(Contract NAS3-2779)
(NASA-CR-54752) Avail: NTIS CSCL 10B

Studies leading to the design and development of solar dynamic power conversion systems which operate on the Brayton cycle are discussed. A design study of cavity-type receivers which employ lithium fluoride as the heat storage medium was conducted. Design and analysis of full scale flightweight receivers, conduction of a series of small scale experiments, and an experimental corrosion properties investigation on selected materials were completed. The results of the full scale design studies and of the small scale experiments are presented. Author

N70-42733*# Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.
CASCADED THERMOELECTRIC TEST GENERATOR Final Report
25 Sep. 1970 102 p Prepared for JPL
(Contracts NAS7-100; JPL-952196)
(NASA-CR-110877; WANL-PR-(DDD)-006) Avail: NTIS CSCL 20C

A two-stage cascaded thermoelectric test generator was designed and fabricated. The design is based on state-of-the-art thermoelectric technology and represents an integration of three proven engineering devices into a compact space power supply test system. The generator consists of a high temperature silicon germanium stage which is thermally coupled to a lead telluride tubular module stage by a sodium heat pipe. A high temperature tantalum electrical heater was designed to thermally simulate a radioisotope heat source. The generator, heat source, and a calorimetric heat sink, were assembled within a vacuum chamber. The design efficiency goal for the cascaded unit is a minimum of seven percent. It is anticipated that the test assembly will demonstrate an overall efficiency of at least 8.8 percent and generate 213 watts of electrical power at reference operating conditions. Author

N70-42951# Naval Ship Engineering Center, Washington, D.C. Propulsion Systems Analysis Branch.
THE 7TH ANNUAL TECHNICAL SYMPOSIUM: A CLOSED BRAYTON CYCLE POWER PLANT FOR UNDERWATER APPLICATIONS AND COMPARISON WITH A FUEL CELL
Harry Balukjian 1970 93 p refs
(AD-709387) Avail: NTIS CSCL 10/2

A 50 KW thermochemical power plant for underwater applications featuring a closed Brayton cycle power loop is described. A typical application to a deep operating submersible is examined and comparisons made with a fuel cell power source. Systems are studied for two depths (8,000 and 20,000 feet) and for three endurances (20, 40 and 120 hours). The analysis of a closed Brayton cycle includes a comparison using several different circulating gases in the loop such as Krypton, Argon and Xe - He. To make this analysis a computer program was developed in which values of enthalpy were obtained by multiplying the specific heat at constant pressure by temperature rather than using gas tables. Calculations are shown for a single fuel cell including the reversible emf and the ideal comparative thermal efficiency. Estimates are also given for the overall comparative efficiency of an actual fuel cell system. Pressure vessels needed to encapsulate the power conversion module and the two reactants account for approximately one half of the total system weight at neutral buoyancy. Calculations are shown for finding the specific fuel and oxidant consumption. This is needed to size the pressure vessels as well as to add to the weight and volume inventory. Author (TAB)

N71-10992# General Electric Co., Philadelphia, Pa. Missile and Space Div.
INVESTIGATION OF A LARGE SCALE NONEQUILIBRIUM MAGNETOHYDRODYNAMIC GENERATOR Annual Report, 1 Aug. 1969 – 31 Jul. 1970
B. Zauderer 31 Jul. 1970 15 p refs
(Contract Nonr-3867(00))
(AD-711351) Avail: NTIS CSCL 10/2

A large portion of the effort of the present contract year was devoted to technology problems, namely, the development of a satisfactory cesium seeding technique, the development of the thermionically emitting electrodes compatible with the shock tube MHD generator, the design of a large MHD magnet, the design of a new MHD channel, and the development of additional diagnostic techniques. A considerable number of MHD experiments with cesium seeded, noble gases were performed. An analytical study of power optimization in linear MHD generators was undertaken. A study of the effect of molecular gases on the generator performance was undertaken. TAB

N71-11062 Oklahoma Univ., Norman.
CONCEPTUAL DESIGN OF A FIVE KW RADIOISOTOPE-FUELED POWER SYSTEM FOR TERRESTRIAL APPLICATIONS
Floyd Olan Calvert (Ph.D. Thesis) 1969 167 p
Avail: Univ. Microfilms: HC $7.80/Microfilm $3.00 Order No. 69-21979

The conceptual design study initially examines various possible dynamic power conversion systems including Brayton, Rankine, Stirling, and Feher power cycles. The direct Rankine cycle is selected for the design study on the basis of the pertinent criteria. Next considered are various possible working fluids for the power cycle. Steam and mercury are determined to be the best working fluids and power cycles are compared using these two fluids. Even though liquid metals are handicapped in terrestrial applications due to high condensing temperatures, it is shown that the liquid mercury cycle may be expected to have as high (or higher) a cycle efficiency as the steam cycle. This is due to the fact that the adiabatic expansion efficiency of the mercury turbine is greater than that for the small steam turbine. The radiosotope heat source subsystem design is considered in some detail and a particular cylindrical geometric arrangement using tungsten metal in the dual role of radiation shield and thermal conductor is recommended. Dissert. Abstr.

N71-11689*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
SURVEY OF MATERIALS FOR THERMIONIC CONVERTERS
Arthur L. Smith Washington Nov. 1970 54 p refs
(NASA-TM-X-2130; E-5789) Avail: NTIS CSCL 11F

The survey is intended for the use of people unfamiliar with the field. The effect of material selection and characteristics on the electrode properties is emphasized. The following areas are explored: (1) materials requirements, (2) identification of materials most likely to meet these requirements, (3) relevant physical and mechanical properties of these materials, and (4) proposals for modifying these materials for improved systems performances. Author

N71-12372# Georgia Inst. of Tech., Atlanta.
AFOSR CONTRACTORS' 11th MEETING ON KINETICS OF ENERGY CONVERSION: ABSTRACTS OF PAPERS
1970 42 p refs Conf. held at Atlanta, 3 4 Sep. 1970
(Grant AF-AFOSR-1308-67)
(AD-712738; AFOSR-70-2232TR) Avail: NTIS CSCL 7/4

The report consists of the agenda and abstracts of papers presented at the Eleventh Annual Contractors Meeting on Kinetics of Energy Conversion. The abstracts describe work now in progress under the sponsorship of the Energetics Division, Directorate of Aeromechanics and Energetics, AFOSR. Subjects discussed in the

papers included the following: hydrogen-oxygen reactions, fluorine reactions, reactions in flames, atomic and molecular beam studies, combustion kinetics, matrix isolation studies, propellant sensitivity, vibrational and electronic relaxation, and lifetimes of metastable species. Author (TAB)

N71-13249 Lockheed Missiles and Space Co., Palo Alto, Calif.
ON THE THERMODYNAMICS OF SYSTEMS OF DIRECT CONVERSION OF THERMAL INTO ELECTRICAL ENERGY
V. A. Grodko et al [1970] 13 p refs Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Energ. i Transp. (Moscow), no. 4, 1970 p 117-126
Avail: National Translations Center, John Crerar Library, Chicago, Ill. 60616

Relations describing the general characteristics of a system performing direct conversion of thermal energy into electrical are derived by thermodynamic analysis. It is shown that in particular cases the relations result in the known equations for characteristics of thermoelectric and thermoemission converters, as well as in regularities underlying the operation of these apparatus, the relations which determine the thermoelectric phenomena, the Richardson equation, etc. A thermodynamic cycle is proposed whose quantitative characteristics are identical, under the assumptions customary for an ideal cycle, to the characteristics of a direct conversion system in both the general and particular cases. Author

N71-15010# Atomic Energy Commission, Washington, D.C.
MAGNETOPLASMADYNAMIC (MPD) CONVERTERS [MAGNETOPLASMADYNAMISCHE (MPD) WANDLER]
W. Peschka et al Sep. 1970 72 p refs Transl. into ENGLISH from German report DLR-FB-69-85
(AEC-tr-7161; DLR-FB-69-85) Avail: NTIS

Theoretical and experimental results on closed-cycle inductive MPD systems are given. Mercury vapor and argon are used as working fluids. Radiofrequency discharges were used for plasma generation. Cryopumping systems are used in the experimental setup with considerable success. Some ideas on the further development of the experimental work are given. Author (NSA)

N71-15039# Minnesota Mining and Mfg. Co., St. Paul, Minn. Electrical Products Group.
DEEP SEA RADIOISOTOPE-FUELED THERMOELECTRIC GENERATOR POWER SUPPLY SYSTEM. SNAP-21 PROGRAM, PHASE 2: 10-WATT SYSTEM Final Summary Report
F. Fox, R. Pannemann, and R. Wickenberg, eds. May 1970 389 p
(Contract AT(30-1)-3691)
(MMM-3691-62) Avail: NTIS

The SNAP-21 system is a radioisotope-fueled thermoelectric generator designed for deep sea applications. It functions by converting the heat from a decaying radioisotope fuel into useful electric energy. This heat energy is converted into electric enerby by a thermoelectric generator. The isotopic fuel supplies heat to the thermoelectric materials and sea water acts as the heat sink to maintain the temperature gradient. Other components are employed to increase efficiency and condition the electric output to the desired form. The components performing these functions are enclosed in a pressure vessel which protects them from sea water pressure and exposure. No external inputs are required to maintain operation of the system. With this type of mechanically-static, unsupported operation, long life with no maintenance is achieved. Data and descriptions are presented on components of SNAP-21 including the heat source, shielding, insulation, thermoelectric generator, power conditioner, pressure vessel, electric receptacle, and generator mounting. Author (NSA)

N71-15242# California Univ., Livermore. Lawrence Radiation Lab.
SOME ECONOMIC ASPECTS OF POWER CONVERSION FOR FUSION REACTORS
P. B. Mohr 15 Sept. 1970 8 p refs Presented at the 'Energy 70' IECEC Conf., Las Vegas, Nev., 21-25 Sep. 1970 Sponsored by AEC
(UCRL-72349; Conf-700912-3) Avail: NTIS

It is considered how increased conversion efficiency made possible by advances in materials, direct conversion and thermodynamic technology may be utilized to offset both fixed and variable costs. Thermonuclear reactors produce power in the form of both neutral and energetic charged particles. Using present power costs as a base, one finds thermodynamic conversion of the energy of neutral particles to be adequate to support internal power requirements as great as 25% of the fusion power, providing capital cost per marketable kilowatt for the entire system is not more than one and one-half to two times that of current fossile fuel systems. On the same basis, the direct conversion of energetic charged particles at high (> 90%) efficiency would allow circulation of internal power approaching the same order as the fusion power. For lesser internal power requirements, high injection and recovery efficiency would allow normalized capital costs from two to three times present values, or, alternatively, power costs could be substantially reduced. Author (NSA)

N71-15562* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
CROSSED-FIELD MHD PLASMA GENERATOR/ACCELERATOR Patent
Alexander P. Sabol, inventor (to NASA) Issued 20 Oct. 1970 (Filed 24 Jan. 1969) 7 p Cl. 315-111; Int. Cl. H01j1/50; Int. Cl. H05j1/00
(NASA-Case-XLA-03374; US-Patent-3,535,586;
US-Patent-Appl-SN-793770) Avail: US Patent Office CSCL 20I

A plasma generator and accelerator is described in which electrode pairs are mounted in a closed channel and a constant magnetic field is applied across the channel. The sides of the rectangular shaped channel parallel to the electrode pairs forms an idler (electrically floating) electrode. A working gas is introduced at one end of the channel. In operation, a main arc, supplied by a continuous power source, is created across the electrode pairs adjacent to the point of gas introduction. As it is being acted on by MHD forces, the main arc moves to the next electrode pair, and so on downstream. Each time a main arc moves to the next electrodes, side arcs are formed between each of the two electrodes of the prior electrode pair and the idler electrode. The side arcs move upstream in the outer sections of the channel and reconnect the electrode pair to form more main arcs. The reconnected main arcs then move downstream because of being acted on by MHD forces. Due to an electrical shorting action, the main arcs extinguish at the last electrode pair. The action of the main arcs accelerates plasma which is omitted from the channel.
Official Gazette of the U.S. Patent Office

N71-15723# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Stuttgart (West Germany). Abt. Magnetofluiddynamische Energiewandlung.
THE FUEL CELL CONCEPT. A REVIEW OF BASIC PRINCIPLES
Richard James Henry Jul. 1970 25 p refs
(DLR-MITT-70-09) Avail: NTIS; ZLDI Munich: 7,60 DM

The discussion of single cell electrochemistry includes performance characteristics of the Apollo fuel cell using hydrogen-oxygen reactants. Modern applications of cells using air oxidant and hydrocarbon fuels are described and the relatively pollutant-free fuel cell exhaust is compared with that from commercial powerplants. Author (ESRO)

N71-15736# California Univ., Livermore. Lawrence Radiation Lab.
DIRECT CONVERSION OF FUSION ENERGY TO ELECTRICITY
R. F. Post 14 Sep. 1970 11 p refs Presented at the Intersociety Energy Eng. Conf., Las Vegas, Nev., 21 -25 Sep. 1970 Submitted for publication Sponsored by AEC
(UCRL-72411; CONF-700915-5) Avail: NTIS

Plasma ions and electrons diffusing out of the confinement zone carry not only kinetic energy imparted by the injection and heating processes employed but also energy derived from the fusion reactions. A method is described for the direct conversion to HVDC, at high efficiency, of energy from charged particle streams emerging from the fusion reactions. The method involves four steps: 1) expansion in static magnetic fields to convert rotational energy components to longitudinal and to reduce the particle stream density; 2) separation of ions and electrons; 3) electrostatic deceleration and selective collection of the separated particle stream to produce dc currents; and 4) reduction of recovered energy to common dc potential for use as HVDC. Theoretical analyses of the overall characteristics of such a system indicate high overall conversion efficiency (90% or greater) and potentially low capital cost per kWe. The possible application of such systems to mirror machines and other types of fusion reactors is discussed, as well as some results from small-scale experiments testing the principles involved. Author (NSA)

N71-16314# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
THERMODYNAMIC ASPECTS OF THE PROBLEM OF IMMEDIATE CONVERSION OF CHEMICAL ENERGY INTO ELECTRICAL
N. S. Lidorenko et al 21 Aug. 1970 21 p Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Energ. i Transp. (Moscow), no. 6, 1969 p 93-101
(AD-713875; FTD-MT-24-114-70) Avail: NTIS CSCL 7/4

The basic aspects of the thermodynamic description of an electrochemical generator were examined. By the thermodynamic methods of balanced processes basic expressions for emf and efficiency of the generator were obtained. The effect of the basic parameters of the working body on generator characteristics were analyzed, and the expressions for optimum temperature, corresponding to maximum efficiency or emf have been found. On the basis of the obtained expressions, the characteristics of the electrochemical generator on a series of possible working bodies were analyzed. The system of equations which described the unbalanced processes in an electrochemical generator were examined. For the generator with an ion-exchange diaphragm on the basis of the accepted model a method of calculating the volt-ampere characteristic is presented. Author (GRA)

N71-17840# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Stuttgart (West Germany). Inst. fuer Energiewandlung und Elektrische Antriebe.
THEORETICAL ANALYSIS OF AN INDUCTIVE, CYLINDRICAL MHD CONVERTER WITH CRYOGENICALLY COOLED WINDINGS [UEBER DIE THEORIE DES INDUKTIVEN ZYLINDERSYMMETRISCHEN MHD-WANDLERS MIT KRYOGEN GEKUEHLTER WICKLUNG]
Andreas Gann Jun. 1970 65 p refs In GERMAN; ENGLISH summary
(DLR-FB-70-25) Avail: NTIS; ZLDI Munich: 17,20 DM

Two dimensional calculations for an infinite length cylindrical converter with a liquid metal incompressible medium and constant channel flow velocity are presented. The effects of eddy-currents induced in the outer channel wall and of the liquid metal viscosity were included. A computer program was developed to evaluate the converter performance. Author (ESRO)

N71-17933*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
TRANSFER FUNCTION DETERMINATION OF THE PRIMARY LOOP OF A CONCEPTUAL NUCLEAR BRAYTON SPACE POWERPLANT
Edward J. Petrik and Arthur W. Kieffer Washington Mar. 1971 45 p refs
(NASA-TM-X-2193; E-5830) Avail: NTIS CSCL 18E

The primary loop of a conceptual nuclear Brayton space powerplant was described by a set of nonlinear differential equations. The equations were simplified and linearized. A phase variable technique was used to determine the transfer functions for small step input disturbances in each of the following: (1) reactivity, (2) lithium flow rate in primary loop, and (3) argon flow rate in power conversion loop. The time response obtained from the transfer functions for the three input disturbances agrees with the time response obtained from the original nonlinear differential equations. Author

N71-18866*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
OPERATING CHARACTERISTICS OF THE PRIMARY FLOW LOOP OF A CONCEPTUAL NUCLEAR BRAYTON SPACE POWERPLANT
George E. Turney, Arthur W. Kieffer, and Edward J. Petrik Washington Mar. 1971 37 p refs
(NASA-TM-X-2161) Avail: NTIS CSCL 18L

An analytical study was made of the steady-state and transient operating characteristics of the lithium cooled primary flow loop of a conceptual nuclear Brayton space powerplant. From the system investigation, it was determined that (1) the steady-state power of the reactor varies linearly with (a) the inserted reactivity and (b) the flow rate of inert gas in the Brayton power conversion loop (2) the flow rate of lithium in the primary loop has a small effect on the reactor steady-state power. The transient changes in the reactor power and temperature of the primary loop were determined for step input disturbances in (1) inserted reactivity, (2) lithium flow rate in the primary loop, and (3) inert-gas flow rate in the Brayton power conversion loop. The response of the system to these step changes can be characterized as stable and highly damped. Author

N71-21693* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
SELF-REPEATING PLASMA GENERATOR HAVING COMMUNICATING ANNULAR AND LINEAR ARC DISCHARGE PASSAGES Patent
Alexander P. Sabol, inventor (to NASA) Issued 25 Jul. 1967 (Filed 24 Feb. 1966) 7 p Cl. 315-111
(NASA-Case-XLA-03103; US-Patent-3,333,152; US-Patent-Appl-SN-531642) Avail: US Patent Office CSCL 20I

A self repeating plasma generator having an annular channel and a linear channel is reported. The linear channel is tangent to the annular channel and is in communication with the annular channel. Electric fields are created in both channels, a magnetic field is created in both channels perpendicular to the electric fields and to the longitudinal dimension of the linear channel, and a gas is pumped into the channels. When an arc is initiated in the annular channel, it is pulled along the channel until it reaches the linear channel where the arc divides into two arcs. One arc proceeds down the linear channel accelerating the gas in front of it, and the other arc proceeds around the annular channel. Hence, an arc will be initiated and then proceed down the linear channel and accelerate the gas in front of it each time the arc in the annular channel makes a revolution. Official Gazette of the U.S. Patent Office

N71-22560*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena. Propulsion Div.
LIQUID METAL MHD POWER CONVERSION
D. J. Cerini *In its* JPL Quarterly Tech. Rev., Vol. 1, No. 1 Apr. 1971 p 64 67 ref (See N71-22551 11-30)
Copyright. Avail: NTIS HC $6.00/MF $0.95 CSCL 20I

A liquid metal magnetohydrodynamic power converter has been successfully operated with the generation of ac electrical power. Gaseous nitrogen is used to produce the closed cycle flow of the liquid metal (NaK) working fluid through the MHD generator where the fluid kinetic energy is converted to electrical energy. The operational characteristics of the converter are given and the results of the current series of tests are discussed. Author

N71-24578*# National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio.
THE POTENTIAL OF NUCLEAR MHD ELECTRIC POWER SYSTEMS
G. R. Seikel and L. D. Nichols 1971 12 p refs Proposed for presentation at AIAA 7th Propulsion Joint Specialist Conf., Salt Lake City, 14–18 Jun. 1971
(NASA-TM-X-67829; E-6304) Avail: NTIS CSCL 18L

The performance of the turbo-MHD cycle is compared with the equivalent Brayton-MHD and Brayton-turboelectric cycles. For the MHD cycles, a top temperature of 2500 K is assumed and two working fluids are considered. For the cycles with turbines, two turbine inlet temperatures are considered: 1500 and 1250K. The cycle temperatures, efficiencies, and specific radiator areas are compared for these various space power systems. The efficiency of the turbo-MHD system is also presented for ground power plants. The specific masses of man shielded 10 MW electric space power systems are estimated. A brief discussion is then presented of the technology of the two most critical components of such an MHD systems. Included in this discussion is a possible modification of the turbo-MHD cycle to minimize the problems associated with alkali-metal-seeded generators and reactor fission product release. Author

N71-24680# General Electric Co., Philadelphia, Pa. Space Div.
EXPERIMENTS IN A LARGE, NON-EQUILIBRIUM MHD GENERATOR WITH CESIUM SEEDED, NOBLE GASES AND HEATED ELECTRODES
B. Zauderer and E. Tate Feb. 1971 19 p refs
(Contracts N00014-70-C-0321; Nonr-3867(00))
(AD-719381; TR-17) Avail: NTIS CSCL 10/2

An experimental study was performed of the operating characteristics of a linear, supersonic Faraday generator, having heated wire electrodes suspended in the gas flow. The test gases were argon, neon, helium seeded with 0.8% cesium. It was observed that locating the electrode outside the cold boundary layer greatly reduced the current ignition voltage at the electrodes below that obtained previously with flush mounted electrodes. However, heating the electrodes to 1600K temperatures produced no significant improvement in the electrode performance over that obtained with room temperature electrodes at current densities of about 10 amp/sq/cm. In both cases, the electrode conduction was through arc spots with cathode losses of about 60V. Author (GRA)

N71-26190# Avco-Everett Research Lab., Everett, Mass.
RESEARCH ON MFD ENERGY CONVERSION Final Report
James E. Klepeis and Jean F. Louis Wright-Patterson AFB, Ohio ARL Nov. 1970 97 p refs
(Contract F33615-69-C-1450)
(AD-720257; ARL-70-0244) Avail: NTIS CSCL 10/2

In noble gases, the elevation of the electron temperature by Joule heating has been clearly demonstrated, but it has also been well established that this nonequilibrium is associated with an ionization instability. The latter leads to electron density nonuniformities and results in a change of the bulk plasma properties. MHD generators driven by molecular or combustion gases and operating at high Hall coefficients are not, a priori, immune from similar instabilities occurring either locally (over the insulators) or in the bulk of the plasma. The purpose of the present study was to determine the bulk properties of the plasma at high Hall coefficients in various molecular gases. The facility used was a disk generator driven by a shock tube. Author (GRA)

N71-26449 Brown Univ., Providence, R.I.
AN ANALYSIS AND DESIGN STUDY OF THE COMPRESSIBLE, TRAVELING WAVE, MAGNETOHYDRODYNAMIC, INDUCTION GENERATOR
Richard Carl Lessmann (Ph.D. Thesis) 1969 161 p
Avail: Univ. Microfilms Order No. 70-8751

The generator is composed of an annular flow passage arranged coaxially with a set of field coils. Interaction between the traveling-wave magnetic field and the moving fluid induces ring currents, in the flow gap, which inductively couple to the field coils. The analysis is based on a set of fundamental equations which neglect the effects of viscosity and heat conduction but admit arbitrary thermal and caloric equations of state. The results are used to investigate the procedure of end coil matching and several electrical characteristics of the generator including: impedance, generated power, and conversion efficiency. The time-averaged flow problem is solved for several different design cases and non-dimensional plots of the results are included. Based on an approximation to the stability criterion it is shown that while no region of parameter space is absolutely stable, maximum stability, for all disturbance frequencies, is obtained when the square of the ratio of the mean Alfven speed to the speed of sound is small. Dissert. Abstr.

N71-26458# Joint Publications Research Service, Washington, D.C.
WORK ON MAGNETOHYDRODYNAMICS (SYMPOSIUM IN THE USA)
V. V. Prokudin *In its* Vestn. of the USSR Acad. of Sci., Vol. 40, No. 6, 1970 31 Aug. 1970 p 127–132 refs
14-30)
Avail: NTIS

Engineering aspects of magnetohydrodynamics are described in brief abstracts of a number of studies. Considered are cyclic magnetohydrodynamic generators working on combustion products, plasma diagnostics and the investigation of discharge electrodes, designs of installations and closed-cycle generators, and channel flow and phenomena of instability. G.G.

N71-27207# Institute of Nuclear Research, Warsaw (Poland).
NUMERICAL CALCULATIONS OF THE ELECTRICAL PARAMETERS IN A FARADAY-TYPE MHD GENERATOR WITH TWO-DIMENSIONAL GAS FLOW
Z. Celinski 1970 34 p refs
(INR-1199) Avail: AEC Depository Libraries

The two-dimensional electrical network was assumed as a model of the two-dimensional gas flow in MHD channels. Applying the calculated velocity and temperature profiles, the network was solved using the GIER computer. All electrical values, the terminal ones as well as local, were calculated. The constant channel cross section, the subsonic gas flow, and the uniform distribution of the gas parameters along the channel were assumed in the calculations. The distribution of the gas parameters was assumed to be independent of the generator loading. The channel end effects were neglected. Author

N71-27918# Kernforschungsanlage, Juelich (West Germany). Inst. fuer Technische Physik.
APPLIED MAGNETOHYDRODYNAMICS. ISSUE 6: PARAMETRIC STUDIES AND DIMENSIONING OF NOBLE GAS MHD GENERATORS [ANGEWANDTE MAGNETOHYDRODYNAMIK. HEFT 6: PARAMETRISCHE STUDIEN UND DIMENSIONIERUNG VON EDELGAS-MHD-GENERATOREN]
Th. Bohn, Chr. Holzapfel, and G. Kolb Oct. 1970 41 p refs In GERMAN; ENGLISH summary
(JUL-706-TP) Avail: AEC Depository Libraries

Several parameters in connection with the total plant loop were considered in designing a MHD Generator for a nuclear MHD power plant. Thus, a limitation was established for the parameters in which it is possible to build the MHD generator without conflicting with the conditions of the other components of the power plant. The two working gases, argon and heliom seeded with cesium, were numerically investigated, using a one dimensional theory. Considering friction losses, the upper limit was calculated for the pressure at which it is possible to gain enough power as a function of Mach number. Several examples of the calculated parameters in the generator are shown. Author (NSA)

N71-28680# Tennessee Univ., Tullahoma. Space Inst.
FLUCTUATIONS IN SERIES CONNECTED OPEN CYCLE MHD GENERATORS
J. B. Dicks, Jr., Y. C. L. Wu, Mary Hall Scott, and E. M. Murray 2 Feb. 1971 15 p refs Presented at the 5th Intern. Conf. on Magnetohydrodynamic Elec. Power Generation, Munich, 19–23 Apr. 1971
(Contract F44620-69-C-0031)
(AD-721454; AFOSR-71-0843TR) Avail: NTIS CSCL 10/2

Fluctuations are present in MHD generators as stated previously in the literature. Attempts to relate these fluctuations to magnetoacoustical waves predicted by theory have not been successful. In this paper one describes another approach to fluctuation analysis. The theoretical and experimental methods used here are those of signal analysis involving functions such as probability density, cross-correlation, auto-correlations and power spectral density. It was found that the fluctuations in Hall voltage, electrode current, temperature, and pressure were all random Gaussian in nature. The probable source of the fluctuations was traced to turbulent fluxuations in the electric sheath properties and to conductivity fluctuations in the channel. Application of probability theory and function space analysis provides a new way of measuring the Hall parameter in the generator. Additional understanding on the operation of series connected generators is obtained through the observation that the fluctuations in the generator output are much lower than those that would be expected from adding the fluctuations of individual electrodes. This indicated that the generator must be studied as a whole in order to understand its behavior and that investigations involving a few electrodes are not sufficient to determine the overall generator performance. Author (GRA)

N71-28718# Tennessee Univ., Tullahoma. Space Inst.
FACTORS EFFECTING THE PERFORMANCE OF DIAGONAL CONDUCTING WALL OPEN CYCLE MHD GENERATORS
Y. C. L. Wu, L. Crawford, R. Shanklin, J. Muehlhauser, and D. Molnar Feb. 1971 19 p refs Presented at Intern. Conf. on Magnetohydrodynamic Electrical Power Generation, 5th, Munich, 19 23 Apr. 1971
(Contract F44620-69-C-0031)
(AD-721455; AFOSR-71-0853TR) Avail: NTIS CSCL 10/2

A systematic study has been undertaken to attempt to evaluate gross factors effecting the overall performance of series connected generators. These factors include combustor performance, chemistry, magnetic field strength, Mach number, and electrode segmentation. The scaling law for the magnetic field is of the form (B - V sub d/ud) squared. Dimensional scaling was investigated by varying the segmentation ratio of electrode length to channel height. The results show that when the electrode length divided by the channel height is changed from the neighborhood of .12 to the neighborhood of .25 then the generator power output decreases by 15 percent over the entire load spectrum. Other studies involving gross generator behavior include an investigation of the effect resulting from the deposit of aluminum oxide and other combustion materials on the walls of the generator. No deterioration of performance was noted during this process. The addition of the powdered aluminum improved the generator performance. During the course of the experimental study, it was found that both the injector head and combustor are very critical to the performance of the generators. Author (GRA)

N71-30458# Kernforschungsanlage, Juelich (West Germany). Inst. fuer Technische Physik.
APPLIED MAGNETOHYDRODYNAMICS. NUMBER 5: MHD-NUCLEAR POWER STATIONS [ANGEWANDTE MAGNETOHYDRODYNAMIK. HEFT 5: MHD-KERNKRAFTWERKE]
T. Bohn, K. Grawatsch, P. Komarek, and G. Noack Aug. 1970 231 p refs In GERMAN
(JUL-689-TP) Avail: AEC Depository Libraries

In an attempt to give a comprehensive representation of the developmental problems facing future magnetohydrodynamic nuclear power plants, an analysis was performed on a number of components. These included: the reactor, MHD generator, transformer, superconducting magnet, heat exchanger, seed material circuit, turbines, and high temperature transmission elements. Following parametric studies of possible design data, specifications could be placed on conventional components, and those requiring special developmental efforts could be identified. It appears that a sufficient technological basis exists for constructing the necessary turbines, heat exchanger, high temperature transmission elements, and electrical transformer. The MHD channel, superconducting magnet, and seed-material circuit need intensive development studies. Technological problems still open are the stability of large superconducting magnets at high magnetic field strengths and the seed material deposition. The biggest development problem lies in the area of high temperature reactors, since an increase in the gas outlet temperature to 2000 C assumes great improvements in coated-particle technology. Circuit optimization and cost studies indicate that the costs of the individual components, with the exception of the reactor, are already well known. Author (NSA)

N71-32212*# Translation Consultants, Ltd., Arlington, Va.
THE POSSIBILITY OF USING MICROWAVE IONIZATION TO OBTAIN NONEQUILIBRIUM PLASMA IN MHD GENERATORS [O VOZMOZHNOSTI ISPOLZOVANIYA MIKROVOLNOVOY IONIZATSII DLYA POLUCHENIYA NERAVNOVESNOY PLAZMY V MGD-GENERATORAKH]
Washington NASA Aug. 1971 11 p refs Transl. into ENGLISH from Ukr. Fiz. Zh. (Kiev), v. 16, no. 5, May 1971 p 705 710
(Contract NASw-2038)
(NASA-TT-F-13783) Avail: NTIS CSCL 20I

The possibility of creating high-conductivity, nonequilibrium plasma at low gas temperature is pointed out. The plasma can be used in MHD generators. Microwave plasma conductivity in excess of 100 mohms/m can be obtained in argon without alkali metal admixtures. Estimates are given for the efficiency of use of this preliminary ionizer in MHD devices. Data obtained are compared with experimental results using electron flow as the preliminary ionizer in MHD generators. Author

N71-33626*# Florida Univ., Gainesville.
RESEARCH ON URANIUM PLASMAS AND THEIR TECHNOLOGICAL APPLICATIONS

Karlheinz Thom and Richard T. Schneider, eds. Washington NASA 1971 503 p refs Symp. held at Gainesville, Fla., 7–8 Jan. 1970 Sponsored by NASA
(NASA-SP-236) Avail: SOD $3.75; NTIS CSCL 18E

Studies on uranium plasma physics and applications, especially in gaseous core reactors, are presented. The topics cover reactor concepts, plasma properties, nucleonics and radiation, nuclear light bulb engines, MHD power generation, nuclear lasers, and containment, flow, and stability. For individual titles, see N71-33627 through N71-33668.

N71-33632*# Computer and Applied Sciences, Inc., Philadelphia, Pa.
GASEOUS FISSION CLOSED LOOP MHD GENERATOR
Arthur Sherman *In* Florida Univ. Res. on Uranium Plasmas and Their Technol. Appl. 1971 p 47–51 refs (See N71-33626 20-22)
Avail: SOD $3.75; NTIS CSCL 18E

The question of achieving a very low specific weight for a nuclear electric space power plant in order that an electrical propulsion system could prove very attractive for space flight is considered. The study of a gaseous fission reactor operating at moderate temperatures in a closed-loop power plant with an MHD generator as the energy converter is suggested. Author

N71-33661*# Avco-Everett Research Lab., Everett, Mass.
MHD POWER GENERATION: STATE OF THE ART AND PROSPECTS FOR ADVANCED NUCLEAR APPLICATIONS
Richard J. Rosa *In* Florida Univ. Res. on Uranium Plasmas and Their Technol. Appl. 1971 p 315–326 refs

Avail: SOD $3.75; NTIS CSCL 18E

State-of-the-art developments in magnetohydrodynamic power generation are reviewed. Base load, emergency, and peaking power generation are included. Economic and environmental factors are considered in relation to MHD generator location. Applications of MHD generators in radiating power plants, propellant-cooled propulsion systems, and commercial industries are cited. J.M.

N71-33663*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
THE PERFORMANCE OF HELIUM SEEDED WITH URANIUM IN A MAGNETOHYDRODYNAMIC GENERATOR
Allan R. Bishop *In* Florida Univ. Res. on Uranium Plasmas and Their Technol. Appl. 1971 p 335–341 refs

Avail: SOD $3.75; NTIS CSCL 18E

The feasibility of using helium seeded with uranium as a working fluid in an MHD generator is discussed. Nonequilibrium ionization of the seed (uranium), including losses due to electrothermal instabilities, is examined over a range of stagnation temperatures (2000 to 4000 K), stagnation pressures (10 to 50 atm), and Mach numbers (0.5 to 1.5). The optimum mixture (for maximum power density) of helium and uranium is about 6 atoms of uranium/1,000 atoms of helium. The nonequilibrium conductivity, including instability losses, is higher than the equilibrium conductivity for the temperature range considered. The output power of a specific generator configuration is presented as a function of stagnation temperature. The helium-uranium mixture is a possible working fluid for MHD generators, although the power density is lower than those for more conventional working fluids. Author

N71-33664*# Georgia Inst. of Tech., Atlanta.
GAS CORE REACTORS FOR MHD POWER SYSTEMS
J. R. Williams and S. V. Shelton *In* Florida Univ. Res. on Uranium Plasmas and Their Technol. Appl. 1971 p 343–349 refs

Avail: SOD $3.75; NTIS CSCL 18E

The MHD generator is examined as one energy conversion device that can extract energy from a working fluid at a very high temperature. Coupled with the gas-core reactor the problem of achieving high electrical conductivities is solved by providing an extremely hot working fluid, and eliminating the high specific impulse nuclear rocket propulsion. This combined concept, with its many advantages is submitted to meet the growing demand for power without thermal pollution. E.M.C.

N71-35233*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
ANALYSIS OF A 35- TO 150-KILOWATT BRAYTON POWER-CONVERSION MODULE FOR USE WITH AN ADVANCED NUCLEAR REACTOR
Paul T. Kerwin Washington Sep. 1971 28 p refs
(NASA-TN-D-6525; E-6352) Avail: NTIS CSCL 18N

Reference parameters were selected for a Brayton power-conversion module with a turbine inlet temperature of 1144 K (2060 R) to be used in a nuclear-reactor-powered system capable of producing up to 450 kilowatts, electric. Unshielded system specific weight is 90 lb/kWe with a specific radiator area of about (30 square feet per kWe) at full power. Author

N71-35623# Joint Publications Research Service, Washington, D.C.
ELECTRODE MATERIALS BASED ON SILICON CARBIDE FOR OPEN CYCLE MHD GENERATORS
G. M. Kafarova et al *In its* Mater. for MHD Generator Channel 31 Aug. 1971 p 20-28 refs
Avail: NTIS

The results of chemical, X-ray diffraction, electron microscopic and other analyses of ceramics based on silicon carbide after about 50 hours of operation in the channel of the U-02 installation are presented. The general laws of change of structure and properties of the material are established. Silicon carbide, alloyed with high-melting metals (Ti, Mo, Cr,) is used as the electrode material for long-term operation in the MHD generator channel up to an electrode surface temperature equal to 1,800 K. Author

N71-35627# Joint Publications Research Service, Washington, D.C.
OXIDE MATERIALS FOR HOT CHANNEL OF OPEN CYCLE MHD GENERATOR
A. B. Ivanov et al *In its* Mater. for MHD Generator Channel 31 Aug. 1971 p 48-58 refs
Avail: NTIS

Information about the properties of oxide electrode materials and the results of testing in experimental channel of open cycle MHD generator is presented. As a result of combined studies on the problem of materials for MHD power plants, the requirements on materials for individual components of MHD generators, the scope of promising materials and the principles for their use in fabrications have been determined. Author

N71-35787*# Scripta Technica, Inc., Washington, D.C.
BRIEF DESCRIPTION OF THE PILOT PLANT INSTALLATION AND THE INCORE-THERMIONIC REACTOR [KURZE BESCHREIBUNG DER VERSUCHSANLAGE UND DES INCORE THERMIONIK-REAKTORS]
NASA Aug. 1971 40 p Transl. into ENGLISH from Incore-Thermionik-Reaktor, Dec. 1970 35 p
(Contract NASw-2036)
(NASA-TT-F-13744) Avail: NTIS CSCL 18E

The high electrical power density of the thermionic converter, the installation of this energy converter in the core of a reactor, and the liquid metal cooling yields a very compact

arrangement for a small power plant. The static operating mode and the property of converting thermal energy at a high temperature into electrical energy, with adequate thermal efficiency, are described. The proposed experimental reactor is a prototype for use in spaceflight. The waste heat is led out of the core at high temperature and the experimental installation is also conceptually oriented toward testing under the environmental conditions of space. These environmental conditions are produced by a vacuum system, which allows simulating the thermal radiation from the reactor tank and reflector surface in space. Author

N71-36450*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
COMBINED TURBINE-MAGNETOHYDRODYNAMIC BRAYTON CYCLE POWER SYSTEM FOR SPACE AND GROUND USE
Lester D. Nichols Washington Oct. 1971 48 p refs
(NASA-TN-D-6513; E-6442) Avail: NTIS CSCL 10A

A combined turbine-MHD generator operating in a Brayton cycle with a NERVA nuclear reactor is considered, both for use in space and on the ground. The combined system is compared with an all-MHD Brayton system and an all-turbine system. The combined cycle systems have higher thermodynamic efficiencies than the other systems. The combined system with 1500 K turbine inlet and the all-MHD system with generator efficiency of 0.8 have the lowest specific recuperator plus radiator mass of those systems considered. But the combined system considered has an average radiator temperature of 200 to 250 K lower than the other. For ground use, a cycle efficiency of greater than 0.55 can be achieved. Author

N71-36452*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
POWER AND LOAD PRIORITY CONTROL CONCEPT FOR A BRAYTON CYCLE POWER SYSTEM
Eugene L. Kelsey and Richard N. Young Washington Oct. 1971 27 p refs
(NASA-TN-D-6478; L-7865) Avail: NTIS CSCL 10B

A load-oriented control system is conceived and applied to a Brayton cycle turbo-alternator. The concept provides speed control and field current control for the alternator and a load simulation which includes energy storage. A laboratory model was constructed and tested with the Brayton cycle demonstrator at the Manned Spacecraft Center. Author

N71-37044# Oak Ridge National Lab., Tenn.
ISOTOPIC ELECTRIC GENERATORS
Francoise Laveissiere Apr. 1971 10 p Transl. into ENGLISH from the French report CEA-Bib-190
(ORNL-TR-2485; CEA-Bib-190) Avail: AEC Depository Libraries

Technical and economic information on the achievements of several countries (USA, France, UK, Euratom, USSR, and Canada) on isotopic electricity generators are presented. Information on the radioisotope used, activity of the source, output wattage, generator lifetime, manufacturer, type of conversion used, generator weight, and primary use are given. Author (NSA)

N71-37309# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
LIMIT CHARACTERISTICS OF AN MHD GENERATOR WITH A NONEQUILIBRIUM PLASMA
A. V. Gubarev et al 29 Jan. 1971 12 p refs Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Energ. Transp. (USSR), no. 1, 1970 p 167-170
(AD-726588; FTD-HT-23-898-70) Avail: NTIS CSCL 10/2

By using known relationships of the energy balance for electrons and dependence of the conductivity of a turbulent plasma on the Hall parameter, the authors obtained useful relationships which permit evaluating the maximum parameters of an MHD generator operating on a nonequilibrium plasma. It is shown that with argon having an addition of cesium vapors at an electric load coefficient of 0.8 the maximum pressure in the reactor must not exceed 100 atmospheres absolute, even at the presently practically limiting values of reactor outlet gas temperature approximately 2500 degrees K, magnetic field induction approximately 10 T, and power of a given single MHD generator channel. It is shown that with a reduction in M number from 2.0 to 0.5 the maximum permissible pressure in the reactor is reduced from 70 to approximatley 20 atm abs. With an increase in initial temperature and the other parameters remaining constant, the maximum value of capacity of a single unit is reduced. The article contains four illustrations. Author (GRA)

N71-37624# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
PROSPECTS FOR THE APPLICATION OF HIGH TEMPERATURE FUEL CELLS
I. L. Kolbenev et al 29 Jan. 1971 11 p refs Transl. into ENGLISH from Energomashinostr. (Moscow), no. 4, 1970 p 30-31
(AD-727497; FTD-HT-23-894-70) Avail: NTIS CSCL 10/2

The work is concerned with prospects for application of high-temperature fuel cells (HTFC) as power sources. Results of analytical research on determination of cell parameters as functions of working process temperature and fuel type are given. Author (GRA)

N71-38010# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
MEASURING DEVICES OF A COMPUTER CONTROL SYSTEM FOR AUTOMATING HEAVY DUTY POWER UNITS OF A THERMOELECTRIC POWER STATION
Yu. I. Semko et al 5 Feb. 1971 14 p Transl. into ENGLISH from the Russian
(AD-727461; FTD-HT-23-899-70) Avail: NTIS CSCL 14/2

In the development of computer controlled measuring devices a large number of factors dealing with the object to be automated should be considered. These include varying voltage, varying temperatures, the location of the equipment and how it is grounded. The equipment is provided with means for protection from overloads and other defects. Author (GRA)

N71-38463# California Univ., Livermore. Lawrence Radiation Lab.
EXPERIMENTAL AND COMPUTATIONAL INVESTIGATIONS OF THE DIRECT CONVERSION OF PLASMA ENERGY TO ELECTRICITY
R. W. Moir, W. L. Barr, R. P. Freis, and R. F. Post 13 May 1971 20 p refs Presented at 4th Conf. on Plasma Phys. and Controlled Nucl. Fusion Res., Madison, Wis., 17-23 Jun. 1971 Submitted for publication; sponsored by AEC
(Conf-710607-126; CN-28/K-1; UCRL-72879) Avail: NTIS

Energy is recovered from mirror and losses by expansion in static magnetic fields (to convert perpendicular energy components to parallel), separation of ions from electrons, and, finally, deceleration and selective collection of the particles after each has lost most of its original kinetic energy. Analysis indicates that overall efficiencies of about 90% might be attainable. In the system being investigated, the energydependent focusing property of periodic electrostatic lenses aids the separation. Computer-derived designs were tested in scaled laboratory experiments, in which variable-energy ion beams were used to study a 22-cell collector system in detail. Under one set of operating conditions the measured efficiency averaged at constant current density over a range of 2 in energy was 88%, whereas computer-simulation calculations for the same case gave 92%; the ideal theoretical maximum efficiency under these conditions would be 97%. Author (NSA)

N71-38510# Office of Naval Research, Arlington, Va.
SUPERCONDUCTING TECHNOLOGY IN JAPAN
Richard G. Brandt Jun. 1971 17 p
(AD-727094; ONR-28) Avail: NTIS CSCL 20/12

Superconducting technology in Japan is in an advanced state and merits continuing attention by outside observers. The university research effort is strong but not unique, with a few exceptions. The real strength is in the industrial effort whose impetus is supplied by the national projects. In the absence of these national projects, there is not enough demand to sustain the many companies involved. High-energy experimental physics and related research efforts are relatively deemphasized in Japan, and thus do not create the same demand for superconducting magnets that exists in our country and in Europe. However, the two national projects--for MHD power generation and the planned project for train levitation--are in the forefront of advancing technology, not duplicated in magnitude by efforts elsewhere. These and other attempts to develop large-scale applications are the most significant aspect of superconducting technology in Japan. Contrasted with these pioneering efforts, research and development on Josephson effect devices lags behind work in progress in other countries. Author (GRA)

N72-10782# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
SOME QUESTIONS OF THE EFFECTIVENESS OF THE PRODUCTION OF ELECTROENERGY IN MHD-GENERATOR IN A NONEQUILIBRIUM PLASMA
A. V. Gubarev, V. V. Breev, and V. A. Gurashvili Feb. 1971 86 p refs Transl. into ENGLISH of the book "Nekotorye Voprosy Effektivnosti Proizvodstva Elektroenergii v MGD-generatorakh na Neravnovesnoi Plazme" Moscow, 1968 p 1-66
(FTD Proj. 6040102)
(AD-724973; FTD-MT-24-253-70) Avail: NTIS CSCL 10/2

The work deals with efficiency of electric power production in magnetohydrodynamic generators, mainly on nonequilibrium plasma, in application to stationary high power plants. The authors prove that the future of such plants with a linear sectional conduction Faraday generator is very doubtful because with given field inductions, given reactor pressure and given gas temperature, which seem to represent the technological limits for the next decade, efficiency of the power plant will not exceed 40 percent. Even with very optimistic assumptions, with a given reactor pressure, power plant efficiency of greater than 50 percent can be reached with a unit power of the magnetohydrodynamic generator of given amount. These low efficiency values of the power plant are due to the fact that the physical operating principle (plasma ionization, and others) of the generator under consideration and its electrogasdynamic circuit prevents achieving high efficiency of internal energy conversion in the channel. GRA

N72-10852*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena. Guidance and Control Div.
MEASUREMENTS OF PLASMA PARAMETERS IN A SIMULATED THERMIONIC CONVERTER
K. Shimada *In its* JPL Quart. Tech. Rev., Vol. 1, No. 3 Oct. 1971 p 97-109 refs
Avail: NTIS CSCL 18K

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14. A VIKING SATELLITE ORBIT TRIM STRATEGY G. R. Hintz p 133-142 refs

N72-11066# Avco-Everett Research Lab., Everett, Mass.
EXPERIMENTAL RESEARCH ON A 400 kW HIGH POWER DENSITY MHD GENERATOR Final Technical Report, Jun. 1967 - Dec. 1970
O. K. Sonju, J. Teno, J. W. Lothrop, and S. W. Petty Wright-Patterson AFB, Ohio AFAPL May 1971 195 p refs
(Contract F33615-67-C-1019; AF Proj. 3145)
(AD-725739; AFAPL-TR-71-5) Avail: NTIS CSCL 10/2

An MHD Generator Facility was designed, constructed and placed in operation. The Facility is described and operating, maintenance, safety and calibration instructions and procedures are given. The Facility was utilized to measure conductivity of hydrocarbon-oxygen combustion gases seeded with cesium salts. A factor of two improvement in electrical conductivity as compared with potassium seeding was observed. A high specific power output (0.5 MW/kg/sec) MHD generator at the 300-400 kilowatt output level was designed and built for cyanogen-oxygen operation. The design of the generator is described, as are the modifications to the AERL Mark II facility which were required in order to test the generator. In spite of the system imperfections encountered the ability of an MHD generator to produce high specific output in the submegawatt power range with conventional hydrocarbon fuels was conclusively demonstrated. Author (GRA)

N72-11610# Centralny Instytut Informacji Naukowo-Technicznej i Ekonomicznej, Warsaw (Poland).
NUKLEONIKA, VOLUME 15, NO. 3, 1970
1970 74 p refs Transl. into ENGLISH from Nukleonika (Poland), v. 15, no. 3, 1970 p 237-316 Sponsored in part by AEC and NSF
(AEC-Tr-7102/3; TT-70-55010/3; UC-34) Avail: NTIS

The effect of the distribution of gas parameters in a cross sectional area of an MHD generator upon its electrical performance was analyzed. The method of electrical equivalent circuits was used. The problem was divided into two parts in order to obtain results in general form: (1) the nonuniformity of gas parameters in a y direction only, and (2) the gas nonuniformity in a z direction. The derived expressions make it possible to determine the distribution of electrical values (current density, electrical potential, and effective gas conductivity) in the channel cross section of the MHD generator, and to calculate its terminal values when the distribution functions of the gas parameters are specified. Author

N72-11639# Kernforschungsanlage, Juelich (West Germany). Inst. fuer Technische Physik.
APPLIED MAGNETOHYDRODYNAMICS. NO. 7: ELECTRICAL LOSSES IN THE MHD GENERATOR (ANGEWANDTE MAGNETOHYDRODYNAMIK. HEFT 7: UBER ELEKTRISC-

HE VERLUSTE IM MHD-GENERATOR]
Christian Holzapfel Mar. 1971 65 p refs In GERMAN; ENGLISH summary
(JUL-742-TP) Avail: AEC Depository Library

By separation of the flow system in an MHD generator into boundary layer and bulk, a simple model of the electrical conditions in the bulk flow of the generator is set up. With this model, the influence of the reductions of the Hall field on the other parameters in the generator is described by use of a generalized characteristic. With increasing magnetic field, a saturation of the Faraday voltage appears. The calculation shows that this saturation appears in the lower region of the magnetic field where no electrothermal instabilities appear. At higher magnetic fields with electrothermal instabilities, the Faraday voltage increases again with increasing magnetic field. Moreover, there exists a lower limit of the velocity below which no nonequilibrium ionization appears if the resistance in the diffusor due to which the Hall field is reduced is too low. On the other hand, there exists an upper limit of the velocity in the subsonic case in a generator with constant cross section above which the Mach number increases to the value 1 due to the energy conversion in the generator. Author (NSA)

N72-11641# Princeton Univ., N.J. Plasma Physics Lab.
CONSIDERATION OF POWER REQUIREMENT IN FUSION FEASIBILITY EXPERIMENT
S. Yoshikawa Jun. 1971 17 p refs
(Contract AT(30-1)-1238)
(MATT-803) Avail: NTIS

Assuming that pseudoclassical diffusion theory holds to the reactor condition, the estimate of power requirement of plasma heating in self-sustaining toroidal fusion devices is made. It is found that various heating methods such as neutral beam injection, rf heating, etc., are reasonably competitive from the power requirement except for the relativistic electron beam injection, which may be financially too difficult. The advantage of the astronspherator combination was noted. Author (NSA)

N72-12136* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
INTEGRATED THERMOELECTRIC GENERATOR/SPACE ANTENNA COMBINATION Patent
Gerald L. Pucillo, inventor (to NASA) Issued 20 Jul. 1971 4 p Filed 29 Oct. 1968
(NASA-Case-XER-09521; US-Patent-3,594,803; US-Patent-Appl-SN-771530; US-Patent-Class-343-720; US-Patent-Class-343-DIG.3; US-Patent-Class-343-840; US-Patent-Class-136-202; US-Patent-Class-136-206; US-Patent-Class-136-227) Avail: US Patent Office CSCL 09E

An integrated thermoelectric generator/antenna is described. An antenna is formed of a sandwich of hot and cold thermoelectric elements, such as bismuth and tellurium. Power storage means are connected to the antenna to receive and store the power generated by the thermoelectric action between the elements. In addition, means are connected to the antenna so that the antenna transmits and receives signals. A separate source of heat is connected to the hot thermoelectric element to provide an auxiliary source of heat for that element when the antenna is not receiving energy from a hot body.
Offical Gazette of the U.S. Patent Office

N72-12166*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
STATUS OF POWER GENERATION EXPERIMENTS IN THE NASA LEWIS CLOSED CYCLE MHD FACILITY
Ronald J. Sovie and Lester D. Nichols [1971] 10 p refs Presented at the 10th Aerospace Sci. Meeting, San Diego, 17-19 Jan. 1972; sponsored by AIAA
(NASA-TM-X-67975) Avail: NTIS CSCL 14B

The design and operation of the closed cycle MHD facility is discussed and results obtained in recent experiments are presented. The main components of the facility are a compressor, recuperative heat exchanger, heater, nozzle, MHD channel with 28 pairs of thoriated tungsten electrodes, cesium condenser, and an argon cooler. The facility has been operated at temperatures up to 2100 K with a cesium-seeded argon working fluid. At low magnetic field strengths, the open circuit voltage, Hall voltage and short circuit current obtained are 90, 69, and 47 percent of the theoretical equilibrium values, respectively. Comparison of this data with a wall and boundary layer leakage theory indicates that the generator has shorting paths in the Hall direction.
Author

N72-13211# General Electric Co., Philadelphia, Pa. Space Div.
INVESTIGATION OF A LARGE SCALE NONEQUILIBRIUM MAGNETOHYDRODYNAMIC GENERATOR Annual Report, 1 Aug. 1970 - 31 Jul. 1971
Bert Zauderer Aug. 1971 19 p refs
(Contract N00014-70-C-0321; Proj. 9800)
(AD-728407) Avail: NTIS CSCL 10/2

The report presents a summary of the progress during the past year on a continuing investigation aimed at determining the operating characteristics of the linear, non-equilibrium MHD generator. The main effort of the past year was concentrated on reducing the electrode losses in the generator by using heated electrodes which protruded into the gas stream. Using an MHD channel, which was specially constructed for this purpose, large scale electrical power was obtained for the first time in cesium seeded, noble gases at gas stagnation temperatures as low as 2000K. Various electrode structures, both hot and cold, were investigated; but the electrode design was not as important as the cesium concentration in determining the electrode drops. During the past year, construction of a larger MHD channel and of a considerably more powerful MHD magnet and power supply were nearly completed. Author (GRA)

N72-13698# Army Foreign Science and Technology Center, Charlottesville, Va.
STUDY OF A MODEL OF AN MHD GENERATOR USING AN ARGON POTASSIUM PLASMA
N. M. Maslennikov and V. N. Germanyuk 21 Jul. 1971 16 p refs Transl. into ENGLISH from the monograph Issledovanie Modeli MGD-Generatora na Argono-Kalievoi Plazme, Magnitogidrodinamicheskii Metod Polucheniya Elektroenergii (USSR)
(AD-728591; FSTC-HT-23-785-71) Avail: NTIS CSCL 10/2

The electrical conductivity of an argon-potassium plasma is measured in an induced electric field with a static gas temperature of 1300-1500K, pressure in the stream 0.04 atm. The currents flowing between electrodes were studied, as well as the cathode and anode voltage drop on potassium-activated electrodes. During optical measurements, the influence of the plasmotron arc on the spectrum and electrical conductivity of the plasma was studied. Author (GRA)

N72-14040# Pratt and Whitney Aircraft, East Hartford, Conn.
A 1.5 KW FUEL CELL POWERPLANT Final Report, 1 Jul. 1970 - 30 Jun. 1971
Thomas G. Schiller and Alfred P. Meyer Jun. 1971 163 p
(Contract DAAK02-70-C-0158; Contract DA Proj.1-G-663702-DG-1003)
(AD-730796; PWA-4210) Avail: NTIS CSCL 10/2

A 1.5 KW fuel cell powerplant was designed for field power supply. The design was validated by testing a breadboard powerplant incorporating the features of the design. It operates automatically on military logistic fuels over a 0-1.65 KW output power range. The powerplant consists of a dual bed regenerative thermal cracker, an air-cooled phosphoric acid fuel cell subsystem, a solid state voltage regulator, and an automatic control unit. The design is validated by 153 hours of operation of a functionally identical breadboard powerplant. An analysis was conducted to determine the potential of the powerplant.
Author (GRA)

N72-16235# Office of Naval Research, London (England).
THE 5TH INTERNATIONAL CONFERENCE ON MAGNETO-HYDRODYNAMIC ELECTRICAL POWER GENERATION
Alfredo Banos, Jr. 16 Jul. 1971 26 p refs Conf. held at Munich, 19-23 Apr. 1971
(AD-730450; ORNL-C-15-71) Avail: NTIS CSCL 10/2

The report gives an account of the last three sessions which included round table discussions by panels of experts. In addition, the Appendix gives a complete list of the papers presented. Author (GRA)

N72-17966# Joint Publications Research Service, Washington, D.C.
THERMODYNAMIC EFFICIENCY OF URANIUM-HEXA-FLUORIDE MHD-PLANTS
I. I. Gutman, V. A. Dmitriyevskiy, and S. D. Tetelbaum 7 Feb. 1972 7 p refs Transl. into ENGLISH from Tepl. Vysokikh Temperatur (Moscow), v. 9, no. 6, Dec. 1971 p 1329-1331
(JPRS-55126) Avail: NTIS

The possibilities for using a gaseous nuclear fuel in a gas reactor and in magnetohydrodynamic plants are considered. The application of uranium hexafluoride is discussed as a nuclear fuel at temperatures providing for ionization of the pure uranium. Problems associated with radiation safety, materials for channels and electrodes, and reactor cooling are reviewed. K.P.D.

N72-20764# Council for Scientific and Industrial Research, Pretoria (South Africa).
WANKEL ENGINES FOR AIRCRAFT
J. Falecki Feb. 1971 10 p refs Transl. into ENGLISH from Tech. Lotnicza i Astronaut. (POLAND), v. 24, no. 6, 1969 p 12-15
(Rept-908) Avail: NTIS

The Wankel engine is compared with conventional and jet aircraft engine for application to light aircraft propulsion. The characteristics of the engines for light aircraft and helicopters are presented. The advantages of the Wankel engine from the standpoint of simplicity, smooth operation, power output, and fuel consumption are examined. Graphs are presented to show the comparative performance of the engines for power output, specific fuel consumption, cost and effects of altitude on power output. Author

N72-21497# Air Force Systems Command, Wright-Patterson AFB, Ohio.
MULTIMEGAJOULE, PULSING, EXPLOSIVE DRIVEN MHD FEASIBILITY STUDY
Ronald Pape Nov. 1971 74 p refs
(AF Proj. 3145)
(AD-735660; AFAPL-TR-71-11) Avail: NTIS CSCL 10/2

The document reports on a preliminary investigation to determine whether explosive driven magnetohydrodynamics (MHD) can be scaled to multimegajoule levels and produce quickly repeating pulses at these high energy levels. In the study, pulse durations below one millisecond are of primary concern. Author (GRA)

N72-23053*# General Electric Co., Lynn, Mass. Aircraft Energy Conversion Div.
FUEL CELL TECHNOLOGY PROGRAM Summary report
25 Aug. 1972 22 p
(Contract NAS9-11033)
(NASA-CR-115572; SPR-046) Avail: NTIS HC $3.25 CSCL 10A

A program to advance the technology for a cost-effective hydrogen/oxygen fuel cell system for future manned spacecraft is discussed. The evaluation of base line design concepts and the development of product improvements in the areas of life, power, specific weight and volume, versatility of operation, field maintenance and thermal control were conducted from the material and component level through the fabrication and test of an engineering model of the fuel cell system. The program was to be accomplished in a 13 month period. Author

N72-23675*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
AN OUT-OF-CORE THERMIONIC-CONVERTER SYSTEM FOR NUCLEAR SPACE POWER
Roland Breitwieser 1972 26 p refs Presented at 3d Intern. Conf. on Thermionic Elec. Power Generation, Juelich, West Germany, 5-9 Jun. 1972
(NASA-TM-X-68049; E-6890) Avail: NTIS HC $3.50 CSCL 18I

Design of the nuclear thermionic space power system, 40 50 70 Kw(e) power range, are given. The design configuration (1) meets the constraints of readily available launch vehicles; (2) allows for off-design operation including startup, shutdown, and possible emergency conditions; (3) provides tolerance of failure by extensive use of modular, redundant elements; (4) incorporates and uses heat pipes in a fashion that reduces the need for extensive in-pile testing of system components; and (5) uses thermionic converters, nuclear fuel elements, and heat transfer devices in a geometrical form adapted from existing incore thermionic system designs. Designs and in some cases performance data for elements and groups of the elements of the system are included. Benefits of the highly modular system approach to reliability, safety, economy of development, and flexibility are discussed. Author

N72-24139# Westinghouse Electric Corp., Pittsburgh, Pa.
THERMOELECTRIC HEATING AND VENTILATING SYSTEM Final Report, Oct. 1969 - Aug. 1971
A. M. Bernard Nov. 1971 35 p ref
(Contract DAAG17-70-C-0044; DA Proj. 1J0-62110-AJ-33)
(AD-737720; USA-NLABS-TR-72-26-CE) Avail: NTIS CSCL 06/17

Modifications and improvements incorporated into a thermoelectric heating and ventilating system are described. The thermoelectric heating and ventilating system is designed to provide a flow of temperature regulated air for use in heating or ventilating a specially designed military clothing ensemble. The system weighs ten pounds unfueled and required 0.26 pounds of fuel for each hour of operation. Eighteen c.f.m. of air S.T.P. conditions at four inches water column pressure is delivered for use in keeping an individual in thermal balance when operating in extreme environments (-40F to +110F) or when exposed to hazards. The electrical power required to obtain the flow of air is supplied by a thermoelectric generator which converts thermal energy directly into electrical energy. The thermal energy is derived from the combustion of liquid military fuels: leaded gasoline, kerosene, JP-4 and diesel fuels. Author (GRA)

N72-24755*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
THE EFFECT OF WALL FRICTION ON MAGNETOHY-DRODYNAMIC GENERATOR PERFORMANCE
Allan R. Bishop Washington May 1972 21 p refs
(NASA-TN-D-6804; E-6436) Avail: NTIS HC $3.00 CSCL 20I

The effect of wall friction on magnetohydrodynamic generator performance is determined by introduction of a wall friction factor into the one-dimensional generator equations. This addition should be useful in improving generator analysis and determining optimum generator geometry. The curves presented can be used to determine the effects of changes in wall friction and generator performance. Wall friction has an increasing effect on the Mach number increases and a decreasing effect as the pressure drop across the generator increase. Author

N72-26031* Westinghouse Electric Corp., Pittsburgh, Pa.
THERMALLY CASCADED THERMOELECTRIC GENERATOR Patent

Robert Flaherty, inventor (to NASA) Issued 30 May 1972 8 p
Filed 24 Jul. 1969 Supersedes N70-10898 (08-01, p 0008)
Sponsored by NASA
(NASA-Case-NPO-10753; US-Patent-3,666,566;
US-Patent-Appl-SN-844355; US-Patent-Class-136-202) Avail: US Patent Office CSCL 10A

A thermally cascaded thermoelectric generator is disclosed. The generator includes a first stage containing high-temperature thermoelectric elements and a second stage containing lower temperature thermoelectric elements. The stages are connected in thermal series by means of an elongated heat transfer pipe containing a liquid metal and a wick. A portion of the heat radiated to the first stage from a high temperature radioisotope source is converted to electricity. The heat rejected by the first stage is conducted to the heat pipe and absorbed by the liquid metal as latent heat of vaporization. The vapor rises to the second stage and condenses to give up latent heat of condensation which is transferred to the second stage and is converted to electricity therein. The condensed liquid returns on the wick to the vicinity of the first stage.
Official Gazette of the U.S. Patent Office

N72-27058* National Academy of Sciences-National Research Council, Washington, D.C.
THEORETICAL EFFICIENCY CONSIDERATIONS FOR PHOTOVOLTAIC ENERGY CONVERTERS
Hans J. Queisser *In its* Solar Cells: Outlook for Improved Efficiency 1972 p 50-55 refs

CSCL 10A

The problem is reviewed of the maximum efficiency of a solar energy converter that can be predicted by first principles and practical efficiency limits that seem reasonable within the state of the art. The p-n junctions in inorganic semiconductors are emphasized. The thermodynamic limit and principal restrictions in approaching this limit are reviewed. Practical improvements beyond today's technology seem possible, especially for silicon, if the knowledge about hole-electron recombination is increased. Brief comments on a variety of proposals for efficiency increase are included. Author

N72-27067# Office of Naval Research, Washington, D.C.
SOME ASPECTS OF JAPANESE ENERGY-CONVERSION RESEARCH AND DEVELOPMENT
Ralph Roberts 29 Feb. 1972 30 p
(AD-739325; ONR-29) Avail: NTIS CSCL 21/9

The Japanese effort in chemical propulsion has shown a marked technological advance in capabilities in the 10 years since the prior visit of the author. However, in spite of this growth, there was little evidence of marked new contributions by the Japanese. For the most part, excellent application has been made of technology developed, primarily in the United States. Continued growth in this field can be anticipated, with increased Japanese capability in satellites orbiting with larger payloads. In addition a shift from solid-propellant to liquid-propellant rockets may take place; however, this is not anticipated within less than 5 years except by licensing from U.S. corporations of purchase of high-thrust liquid-propellant rocket motors. The same situation generally prevails in the fuel-cell and battery activities visited. In this field the close ties to U.S. development, as in the case of solid-propellant rocketry, were apparent. It will be especially interesting to observe the future fuel-cell developments and whether fuel cells will be reduced to submarine practice.
Author (GRA)

N72-27230*# Duke Univ., Durham, N.C. School of Engineering.
REGULATED dc TO dc CONVERTER FOR VOLTAGE STEP-UP OR STEP-DOWN WITH INPUT-OUTPUT ISOLATION Patent Application
Sam Y. M. Feng and Thomas G. Wilson, inventors (to NASA) Filed 18 Apr. 1972 27 p
(Grant NGL-34-001-001)
(NASA-Case-HQN-10792-1; NASA-Case-HQN-10793-1; US-Patent-Appl-SN-245063) Avail: NTIS HC $3.50 CSCL 09E

A closed loop regulated dc-to-dc converter employing an unregulated two winding inductive energy storage converter is described that uses a magnetically coupled multivibrator acting as a duty cycle generator to drive the converter. The multivibrator is comprised of two transistor switches and a saturable transformer. The output of the converter is compared with a reference in a comparator which transmits a binary zero until the output exceeds the reference. When the output exceeds the reference, the binary output of the comparator drives transistor switches which control the multivibrator to turn it off. NASA

N72-28685*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
THE DIMINIODE: A RESEARCH AND DEVELOPMENT TOOL FOR NUCLEAR THERMIONICS
James F. Morris Washington Aug. 1972 17 p refs
(NASA-TM-X-2586; E-6862) Avail: NTIS HC $3.00 CSCL 18J

Diminiodes are fixed-or variable-gap cesium diodes with plane miniature emitters and guarded collectors. In addition to smallness, their relative advantages are simplicity, precision, ease of fabrication, interchangeability of parts, cleanliness, full instrumentation, ruggedness, and economy. With diminiodes and computers used in thermionic performance mapping, a thorough electrode screening program becomes practical. Author

N72-28731# CIT Compagnie Industrielle des Telecommunications, Bruyeres-le-Chatel (France). Centre Pierre Herreng.
THERMOELECTRIC CONVERSION PROCESS: APPLICATION TO RADIOSOTOPE SOURCES
Alais and Stahl 20 Apr. 1971 20 p refs In FRENCH Presented at Intern Conf. on Chem. Sci., Paris, 20 Apr. 1971
(FRNC-Conf-13; Conf-710444-6; Rept-280.71.347) Avail: AEC Depository Libraries

The efficiency of a thermoelectric generator depends on two factors: the conversion yield of the thermoelectric material and the thermal losses due to imperfections in the insulator. The various semiconducting elements used in these generators are classified according to their working temperature; for a given type of material the thermal losses include a term which is independent of the thickness of the insulator. Examples are presented of the GISETTE V, a 15w underwater generator, possessing a 70,000 Ci strontium titanate hot source and GIPSIE, a generator used with pacemakers. The radioisotopes commonly used in thermoelectric generators are listed. NSA

N72-29045# Army Foreign Science and Technology Center, Charlottesville, Va.
THERMOELECTRIC GENERATORS
A. S. Okhotin, A. A. Efremov, V. S. Okhotin, and A. S. Pushkarskii 22 Mar. 1972 369 p refs Transl. into ENGLISH of the publ. "Termoelektricheskiye generatory" Moscow, 1971 p 3-288
(AD-741858; FSTC-HT-23-1023-72) Avail: NTIS CSCL 10/2

The book is devoted to various aspects of the problem of thermoelectric conversion to thermal energy into electric. Examined are physico energetic principles of thermoelectricity, the present state of physics of the thermoelectric process, properties of semi conducting materials, various methods to calculate simple and complex thermoelectric construction. Described are thermoelectric generators of various types, designs and their purpose.
Author (GRA)

N72-29734# Massachusetts Inst. of Tech., Cambridge. Space Propulsion Lab.
RESEARCH ON NONEQUILIBRIUM MHD GENERATORS
Annual Technical Progress Report, 1 Feb. - 31 Dec. 1970

J. L. Kerrebrock Jul. 1971 54 p refs
(Contract F33615-69-C-1226)
(AD-740572; AFAPL-TR-71-45) Avail: NTIS CSCL 10/2

A summary is presented of progress in a study of nonequilibrium generators, with emphasis on the vibrational excitation of molecular species. Experimental work on a large generator includes development of a coaxial preionizer and development of slanted electrode walls, both of which increase the power density of the generator. A three-dimensional analysis of the slanted electrode wall is also given. Finally a preliminary report is given of experimental and theoretical work on the effect of an intense radiation field, coupled to the molecules, on electrothermal instabilities. Author (GRA)

N72-30029*# Pratt and Whitney Aircraft, East Hartford, Conn. South Windsor Engineering Facility.
FUEL CELL TECHNOLOGY PROGRAM CONTRACT SUMMARY REPORT Summary Report
24 Feb. 1972 21 p
(Contract NAS9-11034)
(NASA-CR-128519; PWA-4363) Avail: NTIS HC $3.25 CSCL 10A

A fuel cell technology program which was established to advance the state-of-the-art of hydrogen-oxygen fuel cells using the P and WA PC8B technology as the base is reported. The major tasks of this program consisted of (1) fuel cell system studies of a space shuttle powerplant conceptual design (designated engineering model -1, EM-1) supported by liaison with the space shuttle prime contractors; (2) component and subsystem technology advancement and; (3) a demonstrator powerplant test. Fuel cell system studies, with the EM-1 as the focal point of design activities, included determination of voltage regulation, specific reactant consumption, weight, voltage level and performance characteristics. These studies provided the basis for coordination activities with the space shuttle vehicle prime contractor. Interface information, on-board checkout and in-flight monitoring requirements, and development cost data were also provided as part of this activity. Even though the two vehicles primes had different voltage requirements (115 volts in one case and 28 volts in the other), it was concluded that either option could be provided in the fuel cell power system by the electrical hook-up of the cells in the stack. Author

N72-30655*# Illinois Univ., Chicago. Dept. of Energy Engineering.
MAGNETOHYDRODYNAMIC GENERATOR EXPERIMENTAL STUDIES
Edward S. Pierson 12 Jun. 1972 36 p refs Prepared for JPL
(Contracts NAS7-100; JPL-952985)
(NASA-CR-127891) Avail: NTIS HC $4.00 CSCL 20I

The results for an experimental study of a one wavelength MHD induction generator operating on a liquid flow are presented. First the design philosophy and the experimental generator design are summarized, including a description of the flow loop and instrumentation. Next a Fourier series method of treating the fact that the magnetic flux density produced by the stator is not a pure traveling sinusoid is described and some results summarized. This approach appears to be of interest after revisions are made, but the initial results are not accurate. Finally, some of the experimental data is summarized for various methods of excitation. Author

N72-32078# Whiteley Industries, Inc., Wilmington, Mass.
POWER GENERATING SUBCOMPONENT/FUEL CELL MODULE Final Report, Feb. 1970 - Dec. 1971
R. E. Salathe and R. J. Dumas May 1972 84 p refs
(Contract DAAB07-70-C-0136)
(AD-744477; ECOM-0136-F) Avail: NTIS CSCL 10/2

A hydrazine air fuel cell power generating module capable of 120 watts continuous output was designed, constructed, evaluated. The fuel cell module incorporated design features permitting low cost manufacturing techniques to be used. This approach permits the economic use of the desirable characteristics of a fuel cell power module with the life attainable commensurate with the present state of the art. A fuel cell module from the units delivered was selected at random and subjected to an evaluation test program. The report describes the original design as represented by the Design Plan, the Final Design incorporated in the delivered hardware, and the Evaluation Testing Conducted to assure compliance with the contract technical requirements. Author (GRA)

N72-33063# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
INFLUENCE OF BOUNDARY LAYERS ON THE ELECTRICAL CHARACTERISTICS OF MHD GENERATORS
Yu. M. Volkov, D. D. Malyuta, and V. P. Panchenko 10 Mar. 1972 47 p refs Transl. into ENGLISH of the publ. "Vliyanie Pogranichnykh Sloyev na Elektricheskiye Kharakteriskiki MGD Generators" Moscow, Inst. of Atomic Energy, 1970 p 1-28
(AD-745245; FTD-MT-24-1635-71) Avail: NTIS CSCL 10/2

An analysis is made of the boundary layer effect on the electrical characteristics of a Faraday MHD generator. An electrical substitution circuit and a method for calculating its elements are proposed. An analysis is made of the local circuit for the substitution of a channel in a gas-dynamic approximation. It is noted that the questions of the flow of current through a turbulent boundary layer require careful examination. It has been shown that the existing methods for the calculation of real resistance of a boundary layer, which are based on a break in integration on a certain arbitrary boundary from the electrode, give results which are strongly dependent on the selection of this boundary. Author (GRA)

N72-33065# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
THE PRESENT AND FUTURE OF FUEL CELLS
V. S. Bagotskii and A. M. Skundin 11 Feb. 1972 17 p Transl. into ENGLISH from Khim. v Shkole (Moscow), v. 25, no. 3, 1970 p 10-16
(AD-743651; FTD-MT-24-1687-71) Avail: NTIS CSCL 10/2

Electric cells, fuel cells and heat engines are compared. The most common fuel cell using H2 and O2 is described in detail. Variations such as plastic-based electrodes, ion-exchange membranes, quasi-solid electrolytes, and high temperature cells are discussed. Author (GRA)

N72-33068# Institute of Gas Technology, Chicago, Ill.
LOW-COST ACID FUEL CELL STACKS Final Report
Jun. 1972 108 p refs
(Contract DAAK02-67-C-0063)
(AD-744806) Avail: NTIS CSCL 10/2

The report concerns research to redesign and to improve compact, low-temperature, acid electrolyte fuel cell stacks. These stacks, which use low-platinum loading electrodes, are operated on air and reformed CITE fuel or combat gasoline. Author (GRA)

N73-10247# Magnetic Corp. of America, Cambridge, Mass.
LIGHTWEIGHT SUPERCONDUCTING MHD MAGNETS. VOLUME 1: SADDLE MAGNET DESIGN, CONSTRUCTION AND PRELIMINARY TEST RESULTS Final Report, May 1970 - Mar. 1972
Richard J. Thome and John J. Stekly Jun. 1972 258 p
(Contract F33615-70-C-1567; AF Proj. 3145)
(AD-745321; AFAPL-TR-72-32-Vol-1) Avail: NTIS CSCL 09/1

This is the final report for the development of a superconducting magnet system for magnetohydrodynamic power generation. The information is presented in two volumes. Volume 1 describes the magnet development effort from the initial parametric analyses through design and supporting experimentation to the preliminary testing of the magnet in a vertical bucket type dewar. Author (GRA)

N73-11717# Magnetic Corp. of America, Cambridge, Mass.
LIGHTWEIGHT SUPERCONDUCTING MHD MAGNETS. VOLUME 2: 10 MW LEVEL MAGNET SYSTEM DESIGN AND PROJECTIONS FOR FUTURE DEVELOPMENT Final Report, May 1970 - Mar. 1972
Richard J. Thome and John J. Stekly Wright-Patterson AFB, Ohio AFAPL Jun. 1972 70 p
(Contract F33615-70-C-1567; AF Proj. 3145)
(AD-745322 : AFCRL-TR-72-32-Vol-2) Avail: NTIS CSCL 09/1

This is the final report for the development of a superconducting magnet system for magnetohydrodynamic power generation. The information is presented in two volumes. Volume II describes the parametric optimization and design of a 10 megawatt level MHD superconducting magnet system and projections for future development. Author (GRA)

N73-12064# Argonne National Lab., Ill.
EXPERIMENTAL TWO PHASE LIQUID-METAL MHD GENERATOR PROGRAM Annual Report, 1 May 1971 - 1 May 1972
Lee C. Pittenger Jun. 1972 43 p refs
(Contracts NAonr-7-71)
(AD-747323; ANL/ETD-72-07) Avail: NTIS CSCL 10/2

Earlier analytical and experimental investigations of MHD power systems at ANL have revealed the potential high efficiencies of a constant-liquid-velocity two-phase liquid-metal dc MHD generator for converting fluid energy to electrical energy. These investigations also have identified, and have emphasized the need for in-depth studies of generator parameters affecting attainment of these efficiencies. This report describes the preparations for, and preliminary results of, a programmatic investigation of these parameters; in particular, the effects of relative velocity of the phases, friction, and mixture quality. Author (GRA)

N73-12068# General Electric Co., Philadelphia, Pa. Missile and Space Div.
INVESTIGATION OF A NON-EQUILIBRIUM MAGNETOHYDRODYNAMIC GENERATOR Annual Report, 1 Aug. 1971 - 31 Jul. 1972
Bert Zauderer 31 Jul. 1972 37 p refs
(Contract N00014-70-C-0321; NR Proj. 9800)
(AD-747661) Avail: NTIS CSCL 10/2

The completion of a detailed study of electrode conduction led to the selection of thermionically emitting, cesiated tungsten as the most desirable cathode material for closed cycle, MHD generators. It was also found that with a high cesium ion flux at the cathode, electrode currents considerably higher than thermionic levels could be obtained. Finally, it was shown that the cold aerodynamic boundary layer was a major contributor to the electrode losses. Measurements of the gas dynamic performance of the MHD generator under a wide range of load conditions showed good agreement with the MHD generator theory. For the first time anywhere, 8.5% heat to electric conversion was obtained in the MHD generator at 2100 K in cesium seeded neon. Based on the above results, a new MHD system consisting of a longer and larger MHD channel and a magnet which was three times more powerful than the previous one was constructed and installed in the shock tunnel facility.

N73-12784# Comitato Nazionale per l'Energia Nucleare, Rome (Italy).
STATUS OF THE RESEARCH ON CLOSED CYCLE MHD POWER GENERATION
E. Bertolini, R. Toschi, and V. Zampaglione 17 Dec. 1971 39 p refs
(RT/ING-(71)20) Avail: AEC Depository Libraries

A complete survey of the status of the research and of the potentialities of the nuclear MHD system to convert heat into electricity is presented. The results are reported for both experiments and theories concerning the MHD generator and the studies on high-temperature nuclear reactors. The most significant results in system analysis studies and in the power generation experiments are presented. A critical analysis is made concerning the main mechanisms, still under study, which are reponsible for reductions in the generator performances when compared with the ideal behavior and the scaling laws used so far to extrapolate the present size experimental results for power plant of 1,000 MW(t) or even more. Author (NSA)

N73-12785# Atomic Energy Commission, Oak Ridge, Tenn. Technical Information Center.
CONTROLLED FUSION AND PLASMA RESEARCH: A LITERATURE SEARCH
Milton O. Whitson, comp. Jan. 1972 483 p refs
(TID-3557-1971-Suppl) Avail: NTIS

A bibliography is presented with 2905 references on various aspects of plasma physics and controlled thermonuclear research. Report number, corporate author, and subject indexes are included. Author (NSA)

N73-12800# Florida Univ., Gainesville. Dept. of Nuclear Engineering Sciences.
NUCLEAR GENERATED PLASMAS Final Summary Technical Report, 1 May 1965 - 30 Jun. 1971
William H. Ellis 8 Sep. 1971 408 p refs
(Contracts NOnr-580(18); N00014-68-A-0173-0009; NR Proj. 099-382)
(AD-747681) Avail: NTIS CSCL 20/9

The report presents a survey of the research activities of a Graduate Research program in the area of nuclear generation of plasmas for potential application to MHD electrical power generation from nuclear energy sources. Described are the development of a new plasma diagnostic tool, the Pulsed Ionization Chamber (PIC), its application to plasma kinetic measurements in high pressure gases of the type and in the pressure range used for nuclear reactor coolants and MHD working media, and to wide-range neutron flux and reactor power measurements (over a range of 10 orders of magnitude). Author (GRA)

N73-13056# Army Foreign Science and Technology Center, Charlottesville, Va.
FUEL CELLS AND PROSPECTS FOR THEIR USE IN RAILROAD TRANSPORTATION
V. M. Anisimov 13 Jul. 1972 74 p refs Transl. into ENGLISH of the book "Toplivn. Elementy i Perspekt. Primeneniya ikh na Zheleznodorozhnom Transp." Moscow, Izd. Transp., 1971
(AD-747512; FSTC-HT-23-960-72) Avail: NTIS CSCL 10/2

The principles of the direct conversion of chemical energy into electrical energy are examined. Different types of fuel cells are described and existing power plants and power plants with fuel cells are compared. Author (GRA)

N73-13061# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
PRINCIPLES OF THERMOELECTRONIC AND MAGNETOHYDRODYNAMIC CONVERSION OF ENERGY
K. M. Arefev and I. I. Pakev 2 Jun. 1972 306 p refs Transl. into ENGLISH from the monograph "Osnovy Termoelektronnogo i Magnitogidrodinamicheskogo Preobrazovaniya energii" Moscow, 1970 p 1-215
(AD-748707; FTD-MT-24-1464-71) Avail: NTIS CSCL 10/2

The report deals with the basic physical processes in thermionic and magnetohydrodynamic converters of thermal energy into electrical energy. Data on the operation of the converters are given. The book is intended for engineers and can be used as a textbook by students of technical colleges. Author (GRA)

N73-13665* Tennessee Univ., Tullahoma. Space Institute.
CONTRIBUTIONS FROM SPACE TECHNOLOGY TO CENTRAL POWER GENERATION
John B. Dicks, Jr. *In* NASA. Marshall Space Flight Center

Space for Mankind's Benefit 1972 p 361-368 refs (For availability see N73-13829 04-30)
(Contracts F44620-69-C-0031; DI-14-32-0001-1213)
CSCL 10B

The proceedings of a space congress held at Huntsville, Alabama during November 1971 are presented. The theme of the conference was Space for Mankind's Benefit. The subjects discussed were: (1) man in near-earth space, (2) fundamental benefits of the space program, (3) benefits of orbital surveys and space technology to environmental protection, (4) benefits to telecommunications, navigation and information systems, (5) benefits to future power generations and energy production, and (6) general technology utilization in the public sector. For individual titles, see N73-13830 through N73-13874.

N73-14746# Bureau of Mines, Pittsburgh, Pa. Energy Research Center.
EXPERIMENTAL INVESTIGATIONS OF AN OPEN-CYCLE, VORTEX MHD GENERATOR
George J. Conroy, Roy Kurtzrock, C., Richard B. Snedden, Joseph J. Demeter, Daniel Bienstock, and William F. Hughes (Carnegie-Mellon Univ.) 1972 31 p refs
(BM-RI-7699) Avail: NTIS HC $3.75

Electrical power generation was studied in a laboratory scale, open-cycle vortex MHD generator, which offers several advantages over straight channel generators that require separate combustors. Compactness, lower capital cost, and high energy release are obtained by combining the combustor and generator into one unit in the vortex generator. In addition, the vortex generator uses a simple solenoid rather than the more complex and expensive saddle magnet required for straight channel generators. The primary motivation for this experimental device in terms of ultimate objective was to investigate the vortex generator with applications to direct coal firing and with combustion taking place in specially designed expansion nozzles. The vortex device offers one decided advantage over the linear device in this regard because slag deposits do not degrade or short-circuit the coaxial electrodes as is the case for a linear machine. Power was obtained by impressing an axial field of 3,000 G from an air core solenoid magnet. Tests were conducted by seeding natural gas seeded with potassium acetate and burning with preheated oxygen enriched air. Power generation was lower than calculated because theoretical plasma velocities were not achieved. Author

N73-15757# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Stuttgart (West Germany). Inst. fuer Energiewandlung und Elektrische Antriebe.
GENERAL INVESTIGATION AND PARAMETRIC STUDY OF INDUCTIVE MHD CONVERTERS INCLUDING DESIGN AND DEVELOPMENT OF A CRYOGENICALLY COOLED EXPERIMENTAL 4 kW CONVERTER [ALLGEMEINE THEORETISCHE UNTERSUCHUNGEN UND PARAMETRISCHE STUDIEN UEBER INDUKTIVE MHD-WANDLER SOWIE ENTWICKLUNG UND KONSTRUCTION EINES KRYOGEN GEKUEHLTEN 4-KW-WANDLERS FUER VERSUCHSZWECKE]
Constantin Carpetis and Andreas Gann Apr. 1971 274 p refs
In GERMAN; ENGLISH summary
(DLR-FB-71-74) Avail: NTIS HC $15.75; DFVLR, Porz, West Ger. 80,30 DM

The problems anticipated in calculation and construction of inductive MHD-converters in the power range of a few kilowatts to 50 megawatts are discussed. Detailed analyses for an experimental 4 kW-converter with a cryogenically-cooled winding system are presented. The importance of the major loss mechanisms (channel wall eddy losses, flow friction and skin effect where cryogenic cooling is used), the actual construction problems and the power limits of such converters are stressed. Author (ESRO)

N73-16036# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
THE ENIN-2 EXPERIMENTAL OPEN CYCLE MHD GENERATOR RIG
D. G. Zhimerin, V. A. Bashilov, and V. P. Motulevich 25 Aug. 1972 15 p Transl. into ENGLISH from MHD Symp. (Warsaw), v. 1, 1968 p 2821-2829
(AF Proj. G101)
(AD-751251; FTD-HT-23-559-72) Avail: NTIS CSCL 10/2

An experimental rig has been set up to study the processes taking place in the duct of an open-cycle MHD generator. The installation consists of a combustion chamber unit in which natural gas is oxidized in an air atmosphere enriched with oxygen (to pure O2) with ionizing seeds of different types. The pressure in the duct can go up to 50 atm and the temperature to 3500K. Both the oxygen and the gas are collected in containers of 14 and 3.5 tons capacity, respectively. As the combustion products pass into the duct, the nozzle system can vary the Mach number from subsonic to approximately 3. The duct has a rectangular cross-section. Author (GRA)

N73-16636 Cornell Univ., New York.
THE DESIGN, MODELING, AND OPTIMIZATION OF A SPACE ORIENTED RADIOISOTOPE THERMOELECTRIC POWER SUPPLY Ph.D. Thesis
Alan Weg Schorr 1971 103 p
Avail: Univ. Microfilms Order No. 72-9935

The design, modeling, and optimization of a radioisotope fueled thermoelectric generator is carried out analytically to obtain the lowest weight, highest efficiency generator. The generator has basically a cylindrical configuration and is designed to operate in space and provide on the order of a hundred watts of electric power. Thermocouples are placed cylindrically about the fuel capsule and are heated by radiation alone. The equations describing the thermal-electric model of the generator and fuel capsule are developed. The entire system is optimized using the method of constrained steepest descent to minimize the function f = S2 (1/specific power) + S3 (1/efficiency). Results of the optimization have yielded generators with performance increases of 15 percent in efficiency and of 26 percent in specific power over the General Electric baseline design. The maximum design efficiency obtained is 9.5 percent and the maximum specific power is 4.06 watts/pound for the constraints considered. Dissert. Abstr.

N73-16687# Joint Publications Research Service, Arlington, Va.
MAGNETOHYDRODYNAMIC METHOD OF PRODUCING ELECTRICAL ENERGY, PART 1
V. A. Kirillin, ed. and A. Ye. Sheyndlin, ed. 9 Jan. 1973 207 p refs Transl. into ENGLISH of the book "Magnitogidrodinamicheskiy Metod Polucheniya Elektroenergii" Moscow, Energiya, 1972 360 p
(JPRS-57940-1-Pt-1) Avail: NTIS HC $12.50

A collection of articles on magnetohydrodynamic energy generation is presented. The topics discussed are: (1) the theory and calculation of flows in a MHD generator operating on an equilibrium plasma, (2) experimental investigation of open-cycle MHD generators, (3) investigations of the physical processes and diagnostics in open- and closed-cycle MHD generators, (4) investigations of the basic equipment of MHD generators, (5) investigations of circuits and cycles of power stations with MHD generators, (6) liquid-metal MHD plants, and (7) material for MHD generators. Author

N73-16688# Joint Publications Research Service, Arlington, Va.
MAGNETOHYDRODYNAMIC METHOD OF PRODUCING ELECTRICAL ENERGY, PART 2
V. A. Kirillin, ed. and A. Ye. Sheyndlin, ed. 9 Jan. 1973 209 p refs Transl. into ENGLISH of the book "Magnitogidrodinamicheskiy Metod Polucheniya Elektroenergii" Moscow, Energiya, 1972 360 p
(JPRS-57940-2-Pt-2) Avail: NTIS HC $12.50

A collection of articles on magnetohydrodynamic energy generation is presented. The topics discussed are: (1) the theory and calculation of flows in a MHD generator operating on an

equilibrium plasma, (2) experimental investigation of open-cycle MHD generators, (3) investigations of the physical processes and diagnostics in open- and closed-cycle MHD generators, (4) investigations of the basic equipment of MHD generators, (5) investigations of circuits and cycles of power stations with MHD generators, (6) liquid-metal MHD plants, and (7) material for MHD generators. Author

N73-16718# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
HYDRAULICS OF MAGNETOHYDRODYNAMIC MACHINES
A. V. Tananev 1 Sep. 1972 299 p refs Transl. into ENGLISH of the book "Gidravlika Magnitogidrodinam. Mashin." Moscow, 1970 p 1-271
(AD-751465; FTD-MT-24-2001-71) Avail: NTIS CSCL 20/9

Magnetohydrodynamic machines are examined from the subject of hydraulics. Familiar studies on the motion of viscous incompressible fluid in pipes and in the boundary layer, including flows in the presence of a magnetic field, are generalized with respect to the flows in the circulatory system of magnetohydrodynamic (MHD) machines. Methods of calculating these flows are stated. New results of theoretical and experimental studies on the hydraulic properties of linear MHD machines are given. Author (GRA)

N73-18090# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
ANALYSIS OF THERMAL ECONOMY OF COMBINED POWER INSTALLATIONS EMPLOYING OPEN-CYCLE MHD GENERATORS
L. S. Popyrin, N. N. Pshenichnov, and A. M. Roshchin 27 Oct. 1972 28 p refs Transl. into ENGLISH from MHD Symp. (Warsaw), v. 5, 1968 p 2893-2916
(AD-753031; FTD-HT-23-593-72) Avail: NTIS CSCL 10/2

A mathematical model was used to analyze the thermodynamic efficiency of combined power plants incorporating MHD generators. The mathematical model devised by the authors consists of three parts. The first part is designed to describe processes determining the physical parameters of the working media used. The second part describes processes associated with the conversion and transfer of energy in different elements of the installation, including the MHD generator. The third part is a complex model of an actual power plant (including oxygen enrichment of the oxidant.) When the mathematical model was being designed, actual technical restrictions were taken into account, i.e., the extent to which the parameters could be varied, and some of the technological characteristics of the installation. Author (GRA)

N73-19051 Politecnico di Milano (Italy). Ist. di Macchine.
A METHOD FOR PRELIMINARY ANALYSIS OF MHD GENERATOR PERFORMANCE
C. Casci, A. Coghe, and U. Ghezzi *In* AGARD Energetics for Aircraft Auxiliary Power Systems Feb. 1972 12 p refs

The characteristics of magnetohydrodynamic generators for aircraft and spacecraft applications are discussed. A method for analyzing the parameters of a magnetohydrodynamic generator is developed. The analysis is obtained by fixing the total enthalpic difference between the inlet and outlet sections of the duct and by examining the various possibilities through which such a condition may be achieved. Thermodynamic and electromagnetic quantities are studied in relation to the velocity difference between the inlet and outlet sections of the duct and by some other parameters, such as expansion ratio and form factor of the duct. Author

N73-20931*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
SOLID MEDIUM THERMAL ENGINE Patent Application
James R. Jedlicka, Le Roy. Guist, and Richard M. Beam, inventors (to NASA) Filed 27 Feb. 1973 25 p
(NASA-Case-ARC-10461-1; US-Patent-Appl-SN-336319) Avail: NTIS HC $3.25 CSCL 20M

A thermal engine using a single phase metallic working substance to convert thermal energy directly into mechanical energy is presented. The preferred embodiment of the invention includes a single phase working substance in the form of a cylindrical metallic tube free to rotate about its axis while being subjected to continuous bending moments stressing the body along its axis. The stressing subjects the upper portions of the tube to compression while placing the lower portions under tension as the tube is caused to rotate about its axis. Means are also provided for positioning the tube so that radiant energy is concentrated on that portion of the tube which is under maximum compression. The result is that heat absorbed by this portion causes an imbalance of internal forces which tend to impart a rotational moment to the tube so that is rotates about its axis. NASA

N73-22168# Army Electronics Command, Fort Monmouth, N.J.
ELECTROMECHANICAL ENERGY CONVERSION DEVICES UTILIZING BOTH CONVENTIONAL AND RARE EARTH COBALT PERMANENT MAGNET MATERIALS
R. L. Ross, O. J. Iafrate, and F. Rothwarf Dec. 1972 28 p refs
(DA Proj. 1T0-61102-B-11A)
(AD-756433; ECOM-4064) Avail: NTIS CSCL 09/1

The recent development of the high coercivity, rare-earth alloys such as cobalt-samarium and cobalt-cerium represents a major advance in the field of applied magnetism. The unique properties of these materials promise to revolutionize the design of devices employing permanent magnets. However, as with all new advances in material science, criteria must be established to effectively incorporate the inherent advantages existent within these new materials. Consequently, certain device configurations are not conducive to the incorporation of the new rare-earth cobalt materials. Such a limitation is illustrated in the first design considered: the flux modulation generator which employs conventional Alnico material. The second design discussed in detail is the moving-coil generator employing Co5Sn or Co5Ce material. Both devices may be used to convert mechanical motion into electrical energy and are applicable to improving the power output of existing fluidic generators used to power artillery and rocket fuzing systems. Theoretical predictions are given and alternator configurations are suggested for improving generator performance. Author (GRA)

N73-22662*# Scientific Translation Service, Santa Barbara, Calif.
APPLIED MAGNETOHYDRODYNAMICS, REPORT NO. 10, MHD-TEST FACILITY ARGAS 2: DESCRIPTION AND OPERATIONS
T. Bohn, K. Grawatsch, P. Komarek, H. Lang, and G. Noack Washington NASA May 1973 92 p refs Transl. into ENGLISH from Kernforschungsanlage Julich Ges. mit Beschrankter Haftung, (West Germany) report no. Jul-883-TP, Aug. 1972 p 87
(Contract NASw-2483)
(NASA-TT-F-14876; Jul-883-TP) Avail: NTIS HC $6.75 CSCL 20I

The enlargement of the Argas 2 facility to provide for the use of a superconducting magnet is described including the experimentation zone with nozzle, channel, diffuser, superconducting magnet, and the seed material circuit. Problems occurring during operation are discussed and the cesium circuit is analyzed. F.O.S.

N73-22702# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
SUPERCONDUCTORS IN MARINE TECHNOLOGY
Vladimir B. Zenkevich, Efim Ya. Kazovskii, Mark G. Kremlev, Pervomai V. Orlov, Vyacheslav V. Sychev, Mikhail I. Fedosov, and Valentin N. Shakhtarin 6 Dec. 1972 399 p refs Transl. into ENGLISH of the book "Sverkyprovodniki v Sudonoi Tekh."

1971 p 1-256
(AF Proj. 3145)
(AD-755711; FTD-HC-23-738-72) Avail: NTIS CSCL 20/3

Contents: The nature of superconductors; Materials for superconductive coils; Superconductive solenoids; Superconductive magnetic systems for magnetohydrodynamic transformers; Superconductive magnetic systems for transformers and generators; The use of superconductors in instruments and systems of navigation and steering; Current leads and feed systems for superconductive devices; Cryogenic technology. GRA

N73-22912# Grumman Aerospace Corp., Bethpage, N.Y. Research Dept.
CLEAN AND ATTRACTIVE URBAN POWER SYSTEMS
James T. Yen Aug. 1972 36 p refs Presented at the Intersociety Energy Conservation Eng. Conf., San Diego, Calif., 25-29 Sep. 1972
(RE-439J) Avail: NTIS HC $4.00

The siting and waste problems facing the power industry at the present time are examined. It is proposed that these problems be resolved by integrating clean power plants into community centers. This can be done in such a way that not only power but also year-round recreation and job-training will be enjoyed and utilized by the residents. More specifically, the result is a new type of integrated system that is comprised of total energy gas turbine power plants to be located in underground sites within the community centers, and year-round recreation, job-training, and other facilities to be designed to suit local needs and to be located within the same community centers. Author

N73-23757# Technische Hogeschool, Eindhoven (Netherlands). Groep Direkte Omzetting.
CONDUCTING GRIDS TO STABILIZED MHD GENERATOR PLASMAS AGAINST IONIZATION INSTABILITIES
A. Veefkind Sep. 1972 21 p refs
(TH-72-E-31; ISBN-90-6144-031-9) Avail: NTIS HC $3.25

Ionization instabilities in MHD generators may be suppressed by the use of grids that short circuit the ac electric field component corresponding to the direction of maximum growth. An analysis of the influence of the corresponding boundary conditions has been performed in order to obtain more quantitive information about the stabilizing effect of this system. Author

N73-23765# Avco-Everett Research Lab., Everett, Mass.
EXPERIMENTAL AND ANALYTICAL RESEARCH ON A TWO MEGAWATT, HIGH PERFORMANCE MHD GENERATOR Interim Report, 1 Apr. 1971 - 1 Oct. 1972
O. K. Sonju and J. Teno Oct. 1972 341 p refs
(Contract F33615-71-C-1456; AF Proj. 3145)
(AD-756489; AFAPL-TR-72-98) Avail: NTIS CSCL 10/2

The report presents the initial results of a combined analytical and experimental program whose broad objectives are to achieve a more complete understanding of the operation and appropriate design techniques of compact high-performance MHD generators by further establishing the detailed analytical basis of the performance of these generators and to demonstrate the feasibility of operating compact high-performance MHD generators under a repetitively pulsed mode of operation at high power levels in this case at the 2 MW level. In particular, the results of studies of stability, and effects, transient response, diagnostic, rapid startup, channel voltage breakdown and performance optimization are discussed and summarized. A parallel effort under this program has been directed to constructing a generator test facility and designing and fabricating a 2 MW high-performance MHD generator system to be used in the test facility. Author (GRA)

N73-25102# Bureau of Mines, Washington, D.C.
ECONOMICS OF MIXED POTASSIUM-CESIUM SEEDING OF AN MHD COMBUSTION PLASMA
P. D. Bergman and D. Bienstock Dec. 1972 17 p refs
(PB-214314/7; BM-RI-7717) Avail: NTIS HC $3.00 CSCL 10B

The proposed use of cesium seeded combustion plasmas for open-cycle MHD power generation has attracted considerable interest. Cesium-seeded combustion plasma exhibits a greater electrical conductivity than a potassium-seeded combustion plasma. However, there are drawbacks to cesium seeding such as: the need to use low sulfur coal because of cesium's inability to effectively remove SO2 from the combustion products; the high cost of the cesium ore, pollucite; and cesium's limited availability. Thus, the report looks at the alternative of using a mixture of both potassium and cesium for seeding to overcome these problems. Costs and techniques are also briefly discussed. GRA

N73-25106# Systems Research Labs., Inc., Dayton, Ohio.
CONSTRUCTION AND TEST OF AN MHD GENERATOR CHANNEL AND ELECTRICAL POWER CONVERTER Technical Report, 1 Feb. 1971 - 28 Feb. 1972
R. Nimmo, L. Buechler, and K. Irish Nov. 1972 166 p refs
(Contract F33615-71-C-1425; AF Proj. 3145)
(AD-758783; AFAPL-TR-73-5) Avail: NTIS CSCL 10/2

The AFAPL MHD Facility was placed in operation. A peg wall, diagonally connected MHD channel was constructed, making use of materials evaluated in a Hall channel. Seed handling procedures, a new seeding wheel, and timing relations for the burner, fuel flow, oxygen flow, and seed injection were developed. A series of conductivity tests were conducted, and a conductivity of 10 mho's per meter was established. The MHD generator was run at an output of 800 volts, 125 kW with a 2.2 Tesla magnetic field strength. A 2000 Hz converter was designed, constructed and tested to convert a 600 volts dc input to a 50,000 volts ac output. The MHD generator was operated successfully with the new channel for 15 runs of 4 to 6 seconds each, with no appreciable deterioration of the MHD channel or support equipment. Author (GRA)

N73-26045*# Computer Sciences Corp., Falls Church, Va.
FUEL CELLS: A SURVEY
Bernard J. Crowe Washington NASA 1973 112 p refs
(Contract NASw-2173)
(NASA-SP-5115; LC-72-600266) Avail: NTIS MF $1.45; SOD HC $0.85 Domestic Postpaid or $0.60 GPO Bookstore CSCL 10A

A survey of fuel cell technology and applications is presented. The operating principles, performance capabilities, and limitations of fuel cells are discussed. Diagrams of fuel cell construction and operating characteristics are provided. Photographs of typical installations are included. Author

N73-28665* Georgia Inst. of Tech., Atlanta.
MHD GENERATOR PERFORMANCE LIMITATIONS
R. J. Rosa *In its* Satellite Nucl. Power Station: An Eng. Anal. Mar. 1973 p 23-28
CSCL 18E

The electrical properties of the gas are the primary limiting factor to MHD generator performance; the most relevant electrical properties are the conductivity and the Hall parameter. The maximum allowable pressure at several given levels of power extration vs. temperature is represented graphically. J.A.M.

N73-28667* Georgia Inst. of Tech., Atlanta.
POWER PLANT SYSTEMS ANALYSIS
J. R. Williams and Y. Y. Yang *In its* Satellite Nucl. Power Station: An Eng. Anal. Mar. 1973 p 63-118

CSCL 18E

Three basic thermodynamic cycles of advanced nuclear MHD power plant systems are studied. The effect of reactor exit temperature and space radiator temperature on the overall thermal

efficiency of a regenerative turbine compressor power plant system is shown. The effect of MHD pressure ratio on plant efficiency is also described, along with the dependence of MHD power output, compressor power requirement, turbine power output, mass flow rate of H2, and overall plant efficiency on the reactor exit temperature for a specific configuration. J.A.M.

N73-30699# Kernforschungsanlage, Juelich (West Germany). Inst. fuer Technische Physik.
APPLIED MAGNETOHYDRODYNAMICS. VOLUME 11: OUTLOOK AND POSSIBILITY FOR MHD GAS COMBUSTION GENERATORS WITH AIR TURBINE FOR NUCLEAR PLANT APPLICATION IN THE BRD
G. Noack Oct. 1972 155 p refs In GERMAN
(JUL-892-TP-Vol-11) Avail: AEC Depository Libraries $9.75
Based on the present and on the projected energy needs of West Germany, MHD generators with gas fuel are analyzed. The analysis considers natural gas and air enriched with oxygen to obtain the high temperatures required by the MHD generator. Data about high flame temperatures are listed and discussed in detail. Under the conditions prevailing in West Germany, the best arrangement is offered by an MHD generator with subsequent air turbine. The design of such an arrangement is discussed thoroughly from the technical as well as the structural point of view. NSA

N73-30890# Hercules, Inc., Magna, Utah. Bacchus Works.
EXPLOSIVE MAGNETOHYDRODYNAMIC PROGRAM Technical Report 2 Jan. - 1 Oct. 1972
C. D. Bangerter, L. R. West, T. R. Brogan, D. B. Sheldon, and Z. Stekly May 1973 256 p refs
(Contract F33615-72-C-1394; ARPA Order 2357; AF Proj. 3145)
(AD-762934; H500-12-3-1; AFAPL-TR-73-16) Avail: NTIS CSCL 10/2
The report is basically an analytic study with the addition of design and experimental data required to augment the study. The analysis presented is conclusive in its finding that the X-MHD is a highly versatile prime power source which can be operated without benefit of vacuum equipment in residual ambient pressure gases of various composition and at high repetition rate with various loads. At high repetition rate, the spent explosion products of a previous round are an ideal residual or purge gas. Energy conversion efficiency in excess of 10% should be attainable with optimized residual gases at ambient pressure, and 5-10% with spent explosion product residual gases at field levels currently achieveable with superconducting magnets. (Modified author abstract) GRA

N73-30979# Engelhard Minerals and Chemicals Corp., Newark, N.J. Systems Dept.
OPEN CYCLE FUEL CELL POWER PLANT DIRECT CURRENTS, 1.5 KW Final Technical Report on phase 1, 1 Jul. 1970 - 30 Jun. 1971
O. J. Adlhart, M. F. Collins, R. Michalek, and P. L. Terry Jul. 1973 126 p refs
(Contract DAAK02-70-C-0517)
(AD-764285; SO-70-470-FR) Avail: NTIS CSCL 10/2
The report describes the design of an advanced development model of a portable field electrical power source capable of operation on logistic military fuels. The design was based on and substantiated by full size breadboard testing conducted concurrent with the design effort. The design of the 1.5 KW power plant was verified by the operation of a full scale breadboard system consisting of thermal cracker, fuel cell, and control module. The power conditioner was not tested in breadboard form. The switching transistor and drive circuitry, however, were tested on fuel cell output. Full scale breadboard testing of the integrated system was limited to 21 hours during which the system produced 1.25 KW at a fuel rate of 2.5 lbs/hr of JP-4. (Modified author abstract) GRA

N73-31848# Army Foreign Science and Technology Center, Charlottesville, Va.
DEVELOPMENT AND INVESTIGATION OF HIGH TEMPERATURE COMBUSTOR TO BE USED FOR A SOLID FUEL MHD GENERATOR AND THERMODYNAMIC ANALYSIS OF COMBUSTION CONDITIONS
S. A. Tager 13 Mar. 1973 16 p refs Transl. into ENGLISH from the publ. "5th International Conference on MHD Analysis of Combustion Conditions" Munich, Apr. 1971 15 p
(AD-764153; FSTC-HT-23-2007-72) Avail: NTIS
The basic principles of the high-temperature combustion of natural solid fuel are formulated. Variants are optimized; the scheme of a vertical cyclone with lower gas discharge, hardened slag lining protection of walls, and side removal of slag was adopted. Complete preliminary mixing of dry coal dust with all the high-temperature heated air and uniformly distributed feed of a ready dust-air mixture along the entire cyclone perimeter were carried out. A revised method of calculating high-temperature regimes for the combustion of solid fuel is presented that takes into account the actual operating conditions of the combustion chamber. The maximum attainable temperatures in the combustion of natural fuel were estimated. The combustion chamber, methods and conditions of the experiments are described. (Modified author abstract) GRA

N73-31991*# Techtran Corp., Glen Burnie, Md.
CALCULATION AND COMPARISON OF THE ECONOMICS OF ELECTROCHEMICAL FUEL CELLS
F. A. Pohl, J. Boehm, and H. Carl Washington NASA Oct. 1973 17 p refs Transl. into ENGLISH from Wiss. Ber. AEG-Telefunken (West Germany), v. 45, no. 3, 1972 p 141-146
(Contract NASw-2485)
(NASA-TT-F-15147) Avail: NTIS HC $3.00 CSCL 10A
The economic benefits are considered to be derived from various types of electrochemical fuel cells. It is found that the tungsten carbide-carbon cell is most economic in the low temperature fuel cell range, and that high fuel costs are more significant than high investment costs. Author

N73-31996# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
MAGNETOHYDRODYNAMIC GENERATOR FOR A COMBINED MAGNETOHYDRODYNAMIC ELECTRIC POWER PLANT WITH A FIRST GENERATION OPEN CYCLE
B. Ya. Shumyatskii, M. G. Koryagina, P. P. Ivanov, and V. I. Kovbasyuk 31 Jul. 1973 28 p refs Transl. into ENGLISH from unidentified Russian monograph
(AF Proj. 3145)
(AD-764925; FTD-MT-24-713-73) Avail: NTIS CSCL 10/2
Contents: Preliminary analysis of the best magnetic systems; Variation problem in the technical and economical optimization of an MHD generator; Characteristics of optimum MHD generators. GRA

N73-32109* Catholic Univ. of America, Washington, D.C.
ELECTROMAGNETIC WAVE ENERGY CONVERTER Patent
Robert L. Bailey, inventor (to NASA) Issued 18 Sep. 1973 7 p Filed 27 Sep. 1972 Supersedes N73-11205 (11 - 02, p 0149) Sponsored by NASA
(NASA-Case-GSC-11394-1; US-Patent-3,760,257;
US-Patent-Appl-SN-292698; US-Patent-Class-321-1.5;
US-Patent-Class-136-89; US-Patent-Class-250-212) Avail: US Patent Office CSCL 10A
Electromagnetic wave energy is converted into electric power with an array of mutually insulated electromagnetic wave absorber elements each responsive to an electric field component of the wave as it impinges thereon. Each element includes a portion tapered in the direction of wave propagation to provide a relatively wideband response spectrum. Each element includes an output for deriving a voltage replica of the electric field variations intercepted by it. Adjacent elements are positioned relative to

each other so that an electric field subsists between adjacent elements in response to the impinging wave. The electric field results in a voltage difference between adjacent elements that is fed to a rectifier to derive dc output power.
Official Gazette of the U.S. Patent Office

N73-33009# Naval Ship Research and Development Center, Annapolis, Md.
HIGH-POWER DENSITY HYDRAZINE FUEL CELLS
D. E. Icenhower and H. B. Urbach Jun. 1973 17 p refs
(SF35431005)
(AD-764530; NSRDC-3934; NSRDC-27-381) Avail: NTIS CSCL 10/2

A hydrazine-oxygen fuel cell was operated under moderate conditions of temperature and concentration at power densities up to 600 watts per square foot (1000 amperes per square foot at 0.6 volt). At this output, a power efficiency of 32% was obtained at 70C at less than molar hydrazine concentration. Power efficiencies exceeding 48% were obtained over a power density range from 40 to 200 watts per square foot by matching the temperature and hydrazine concentration optimally to the electrical load. The three major components of cell polarization were examined. Critical resistance losses were minimized by use of a 0.010-inch asbestos matrix which was more than adequate to prevent leakage of oxygen to the anode at moderate differential pressures. A projected cell thickness of 0.1 inch and a power density of 200 watts per square foot correspond to a calculated stack power-volume ratio of 16 kilowatts per cubic foot. (Modified author abstract) GRA

06 ENERGY TRANSPORT, TRANSMISSION, DISTRIBUTION

Includes technological or economic viewpoints in the transport of fuels; transport by pipes, tubes, etc; microwave transmission; laser transmission.

A71-36202 **Transformation, transport and accumulation of energy in hydrostatic power transmission systems (Transformation, Transport und Speicherung von Energie in hydrostatischen Energieübertragungen).** W. M. J. Schlösser. In: Development of fluid power transmissions and control systems; Verein Deutscher Maschinenbau-Anstalten and Deutsche Messe- und Ausstellungs, Conference on Oil Hydraulics and Pneumatics, Hanover, West Germany, April 26, 27, 1971, Conference Report Volume (Entwicklung fluidischer Antriebe und Steuerungen; Verein Deutscher Maschinenbau-Anstalten and Deutsche Messe- und Ausstellungs, Fachtagung über Ölhydraulik und Pneumatik, Hanover, West Germany, April 26, 27, 1971, Tagungsberichtsband). Hanover, Deutsche Messe- und Ausstellungs-AG, 1971, p. 9-30. 26 refs. In German.

An attempt is made to break down hydrostatic power transmission systems into groups using different mechanisms of power transformation, transport and accumulation, such as mechanical, electrical, pneumatic and hydraulic power carriers. A graphical representation of this classification is given. Special attention is given to the high pressure processes used in these systems. The study is designed to provide the designer with a means for selecting the desirable information from a large volume of available data. Mass, heat, optical, chemical, mechanical, electrical, pneumatic and hydraulic energies are covered. V.Z.

A72-35328 * # **Laser power stations in orbit.** C. F. Hansen and G. Lee (NASA, Ames Research Center, Physical Gasdynamics and Lasers Branch, Moffett Field, Calif.). *Astronautics and Aeronautics,* vol. 10, July 1972, p. 42-55. 52 refs.

Potential laser applications for space-borne power generation are discussed in the light of the current state of the art. The feasible ranges of various laser classes with standing waves are estimated. Power and efficiency, mirror factors, phased-array performance and beam patterns are analyzed as selection characteristics. Other topics include the maximum receiving-element size, energy conversion, pointing and tracking, causes of deformation, and mirror distortions. It is theorized that a nuclear-fueled laser satellite could beam power to distances twice the earth-sun distance with predictable pointing accuracies. V.Z.

A73-22822 * **Laser energy transfer - An analytic survey of high power applications.** R. D. Arno, J. S. MacKay, and K. Nishioka (NASA, Ames Research Center, Advanced Concepts and Missions Div., Moffett Field, Calif.). In: Intersociety Energy Conversion Engineering Conference, 7th, San Diego, Calif., September 25-29, 1972, Proceedings. Washington, D.C., American Chemical Society, 1972, p. 1116-1124. 10 refs.

A73-33183 # **A resource carrying aircraft for remote regions.** V. H. Atrill. In: Anglo-American Aeronautical Conference, 13th, London, England, June 4-8, 1973, Proceedings. (A73-33176 16-02) London, Royal Aeronautical Society, 1973. 12 p.

Consideration of the possibility of using very large aircraft for the first-leg movement of liquid and gaseous fossil fuels from the Canadian and American Arctic. The known liquid and gaseous fossil fuel resource situation in the Canadian and American Arctic is briefly summarized, and the pipeline proposals actively being promoted are cited. In view of the heavy expenditures for these pipelines, a very large resource-carrying aircraft for first-leg movements is proposed which has a payload of close to 1200 tons for a mission of 500 nautical miles. It is claimed that these vehicles can operate in the Arctic 18 to 18.5 hours per day. They will cruise at about 400 knots. Their estimated cost is eighty million dollars per aircraft. A.B.K.

N68-14618 Lockheed Missiles and Space Co., Sunnyvale, Calif.
THE THREE-INDEX TRANSPORT PROBLEM
G. D. Rakhmanin, S. S. Surin, and G. V. Shalabin [1967] 10 p
Transl. into ENGLISH from the book "Application of Mathematics to Economics" Leningrad, Leningrad Univ. Press, 1965 p 124-133

An algorithm is developed for the transport and storage problem in the petroleum industry for the optimal location of the industry in a geographic region. The stages covered are storage at the refinery, transport to the distributor, storage at the distributor's, and transport to the consumer. For a short-range planning problem, only the current expenditures are considered. For long-range planning the capital expenditures at storage and refinery areas and in the transport are also included. N.E.N.

N69-27096# Commissariat à l'Energie Atomique, Paris (France).
TECHNICAL ASPECTS AND ECONOMIC INCIDENTS OF TRANSPORTATION IN THE FUEL CYCLE [ASPECTS TECHNIQUES ET INCIDENCES ECONOMIQUES DES TRANSPORTS DANS LE CYCLE DES COMBUSTIBLES]
Y. Sousselier and M. Labrousse [1968] 21 p refs In FRENCH
Presented at the Symp. on Econ. on Nucl. Fuels, Gottwaldov, Czech., 27 May 1968
(CEA-CONF-1093; CONF-680541-1) Avail: AEC Depository Libraries

The power reactor fuel cycle is discussed from the French point of view. Areas of U loss during processing and reprocessing are listed. Safety and economic aspects are discussed. Methods of fuel and spent fuel transportation used for semidefinite Chinon reactors and Bugey Power Reactor are described; the advantages of using Pb shielded casks are considered. Costs of transporting spent natural U fuel are detailed; cost breakdowns are given for France. Transportation costs for $UO_2(NO_3)_2$, Pu, and enriched U are considered briefly. Total fuel cycle costs for a gas-cooled graphite reactor are considered. NSA

N69-37570# Oak Ridge National Lab., Tenn.
SAFETY STUDIES OF FUEL TRANSPORT
In its Chem. Technol. Div. Sep. 1968 p 249 255 refs

Avail: CFSTI

Criteria to provide a series of cask design standards and specifications which, if followed, should insure adherence to requirements set forth in Atomic Energy Commission regulations are under development. Suitable engineering standards are to be established for the design, fabrication, and inspection of irradiated-fuel shipping casks; these will provide information on structural integrity, shielding, heat transfer, criticality, materials of construction, and fabrication techniques. Specification and standards presented are to be based on data from experiments and analyses. Approximately 85% of the criteria have been documented. A.C.R.

N70-10537# Massachusetts Inst. of Tech., Cambridge. Fluid Mechanics Lab.
THE SPREAD OF OIL SLICKS ON A CALM SEA
James A. Fay Aug. 1969 15 p refs *Its* Publ. no. 69-6
Avail: CFSTI

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Oil, when spilled on water, tends to spread outward on the water surface in the form of a thin continuous layer. In those instances where this layer is as thin as a wave length of visible light, an iridescent color of the film, caused by light interference, is observed. This tendency to spread is the result of two physical forces: the force of gravity which causes the lighter oil to seek a constant level by spreading horizontally, just as it would on a plane horizontal solid surface, and the surface tension force of pure water, which is usually greater than that of the oil film floating on water. While the oil layer could spread while still remaining intact until it had formed a monomolecular layer, spreading usually stops when the layer is much thicker than this, most likely because of a change in the surface tension properties of the oil. Author

N70-14391# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
SOME CHARACTERISTICS OF THE PROTECTIVE EFFECT OF PETROLEUM SOLUBLE CORROSION INHIBITORS FOR IRON IN THE ELECTROLYTE-HYDROCARBON TWO-PHASE SYSTEM
A. A. Gonik 24 Jul. 1969 10 p refs Transl. into ENGLISH from the book "Nauchno. Teknicheskogo Soveshchaniya po Zashchite c Korrozil Oborudovaniya Neftyanykh i Gazovykh Skvazhin" Baku, Izd AN Azerb. SSR, 1964 p 69-80
(AD-694781; FTD-MT-24-20-69) Avail: CFSTI CSCL 13/8

The report concerns certain peculiarities of the protective action of oil-soluble hydrogen-sulfide corrosion inhibitors in the system of hydrocarbon-aqueous acid condensate of oil field gas pipes. Author (TAB)

N70-42226# Naval Research Lab., Washington, D.C.
THE REMOTE SENSING OF OIL SLICKS BY RADAR
N. W. Guinard and C. G. Purves 1 Jun. 1970 35 p refs
(AD-709982) Avail: NTIS CSCL 13/2

The NRL Four Frequency Radar System, at Coast Guard request, was flown over the oil slick caused by the wreck of the tanker Arrow in the Chedabucto Bay area of Nova Scotia on 17 February 1970. The oil slick was mapped remotely from an EC-121 aircraft in both the horizontal and vertical polarizations. Synthetic aperature imagery was obtained in the P, X, L and C-band. This data clearly established the value of the radar sensing techniques as a tool for locating and monitoring oil spills. Author (TAB)

N71-20975*# McDonnell Douglas Astronautics Co., Huntington Beach, Calif.
ELECTRICAL POWER DISTRIBUTION AND USAGE
J. K. Jackson and N. A. Jones *In* NASA. Langley Res. Center Prelim. Results from an Operational 90-day Manned Test of a Regenerative Life Support System 1971 p 301-312

Avail: NTIS HC$6.00/MF$0.95 CSCL 09E

The electrical power subsystem for the 90-day test included 60 Hz, 115 Vac, 1 phase; 400 Hz, 120/208 Vac, 3 phases; and 28 Vdc. Power usage was recorded by watt-hour meters on each 60-Hz circuit, watt meters on each 400-Hz circuit, and ammeters and voltmeters on the dc circuits. Automatic recording of power data was provided by six power sensors on groups of the ac circuits and a shunt in the dc circuits. These signals were recorded on the low-speed data system. Electrical energy usage was 8,169 kWh on the 60-Hz circuits, 5,885 kWh on the 400-Hz circuits, and 2,267 kWh on the dc circuits. The total energy was 16,012 kWh for an average power consumption of 7,426 watts. Power and energy requirements of each unit are presented. Author

N72-23979# RAND Corp., Santa Monica, Calif.
THE EFFECT OF FUEL PRICE INCREASES ON ENERGY INTENSIVENESS OF FREIGHT TRANSPORT
W. E. Mooz Dec. 1971 55 p refs
(Grant NSF GS-31253)
(R-804-NSF) Avail: NTIS HC $4.75

The use of energy for transporting U.S. intercity freight and the effect of higher fuel price are analyzed. Methods of estimating unit energy consumption are developed and applied to determine average values and trends. Water transport is found to consume an average 500 BTU per ton/mile, rail 750, pipeline 1850, truck 2400, and air cargo 63,000, or 45 times the average for all transport modes in 1968. Only a small shift to air freight, from the present less than 0.2% to 2% of all intercity ton/miles, would double the average unit energy consumption for all freight modes. If present trends continue, this increase will occur by the year 1996. Because of its high fuel consumption, however, air freight growth would tend to be inhibited by higher fuel prices, while surface transport would be little affected. Higher fuel prices may result from shortages, the cost of environmental constraints, new taxes, or other reasons. Author

N73-18981*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
AIR-CUSHION TANKERS FOR ALASKAN NORTH SLOPE OIL
John L. Anderson Washington Mar. 1973 30 p refs
(NASA-TM-X-2683; E-7210) Avail: NTIS HC $3.00 CSCL 01C

A concept is described for transporting oil from the Arctic to southern markets in 10,000-ton, chemically fueled air-cushion vehicles (ACV's) configured as tankers. Based on preliminary cost estimates the conceptual ACV tanker system as tailored to the transportation of Alaskan North Slope oil could deliver the oil for about the same price per barrel as the proposed trans-Alaska pipeline with only one-third of the capital investment. The report includes the description of the conceptual system and its operation; preliminary cost estimates; an appraisal of ACV tanker development; and a comparison of system costs, versatility, vulnerability, and ecological effect with those of the trans-Alaska pipeline. Author

N73-30464*# Massachusetts Inst. of Tech., Cambridge.
SOME PROBLEMS AND PROSPECTS FOR MARINE TRANSPORTATION OF OIL IN THE 1970S
Zenon S. Zannetos Mar. 1973 21 p refs Presented at the Energy: Demand, Conserv. and Institutional Probl. Conf., Cambridge, Mass., 12-14 Feb. 1973
(Grant NGL-22-009-309)
(NASA-CR-133854; Rept-649-73) Avail: NTIS HC $3.25 CSCL 05C

The problems associated with, and the financial resources required for ocean transportation of petroleum in the 1970s are discussed in terms of the energy crisis. Spot rate fluctuations for tankers are examined along with the financial requirements for ocean transportation. F.O.S.

N73-33900*# New Mexico Univ., Albuquerque. Technology Applications Center.
HEAT PIPE TECHNOLOGY: A BIBLIOGRAPHY WITH ABSTRACTS Cumulative Volume
31 Mar. 1971 239 p refs Sponsored by NASA
(NASA-CR-135953; TAC-Bibl-1) Avail: NTIS HC $14.00 CSCL 20M

A cumulative bibliography on heat pipe research and development projects is presented. The subjects discussed are: (1) general information, (2) heat pipe applications, (3) heat pipe theory, (4) design and fabrication, (5) testing and operation, (6) subject and author index, and (7) heat pipe related patents. Author

N73-33901*# New Mexico Univ., Albuquerque. Technology Applications Center.
HEAT PIPE TECHNOLOGY Quarterly Update, 1 Jan. - 31 Mar. 1972

31 Mar. 1972 26 p refs Sponsored by NASA
(NASA-CR-135956; TAC-BIBL-1(72/1)) Avail: NTIS HC $3.50 CSCL 20M

A bibliography of heat pipe technology to provide a summary of research projects conducted on heat pipes is presented. The subjects discussed are: (1) heat pipe applications, (2) heat pipe theory, (3) design and fabrication, (4) testing and operation, (5) subject and author index, and (6) heat pipe related patents. Author

N73-33902*# New Mexico Univ., Albuquerque. Technology Application Center.
HEAT PIPE TECHNOLOGY: A BIBLIOGRAPHY WITH ABSTRACTS Quarterly Update, 1 Apr. - 30 Jun. 1972
30 Jun. 1972 35 p refs Sponsored by NASA
(NASA-CR-135955; TAC-BIBL-1(72/2)) Avail: NTIS HC $3.75 CSCL 20M

A bibliography of heat pipe research and development projects conducted during April through June 1972, is presented. The subjects discussed are: (1) general information, (2) heat pipe applications, (3) heat pipe theory, (4) design and fabrication, (5) test and operation, (6) subject and author index, and (7) heat pipe related patents. Author

N73-33903*# New Mexico Univ., Albuquerque. Technology Application Center.
HEAT PIPE TECHNOLOGY: A BIBLIOGRAPHY WITH ABSTRACTS Quarterly Update, 1 Jul. - 30 Sep. 1972
30 Sep. 1972 42 p refs Sponsored by NASA
(NASA-CR-135952; TAC-BIBL-1(72/3)) Avail: NTIS CSCL 20M

A bibliography of heat pipe research and development projects conducted during July through September, 1972 is presented. The subjects discussed are: (1) general information, (2) heat pipe applications, (3) heat pipe theory, (4) design and fabrication, (5) testing and operation, (6) subject and author index, and (7) heat pipe related patents. Author

N73-33904*# New Mexico Univ., Albuquerque. Heat Pipe Information Office.
HEAT PIPE TECHNOLOGY: A BIBLIOGRAPHY WITH ABSTRACTS Annual Supplement, 1971
1971 102 p refs
(NASA-CR-135951; TAC-Bibl-1(71/2)) Avail: NTIS HC $7.25 CSCL 20M

The annual supplement on heat pipe technology for 1971 is presented. The document contains 101 references with abstracts and 47 patents. The subjects discussed are: (1) heat pipe applications, (2) heat pipe theory, (3) design, development, and fabrication of heat pipes, (4) testing and operation, (5) subject and author index, and (6) heat pipe related patents. Author

07 ENERGY STORAGE

Includes flywheels, springs; heat stored in rocks, metals and other materials; nickel-cadmium batteries, lithium-sulfur batteries, solid electrolytes.

A68-12853
COMPOSITE FLYWHEEL STRESS ANALYSIS AND MATERIALS STUDY.
George F. Morganthaler and Stanley P. Bonk (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.).
IN: ADVANCES IN STRUCTURAL COMPOSITES; SOCIETY OF AEROSPACE MATERIAL AND PROCESS ENGINEERS, NATIONAL SYMPOSIUM AND EXHIBIT, 12TH, ANAHEIM, CALIF., OCTOBER 10-12, 1967, PAPERS.
North Hollywood, Calif., Western Periodicals Co. (SAMPE Science of Advanced Materials and Process Engineering. Volume 12), 1967. 14 p. 5 refs.

Lightweight, high-strength flywheels are of interest for short-term energy storage because of their potentially high energy-to-weight ratio. The feasibility of producing such a flywheel by using a composite Fiberglas-epoxy structure was investigated. A stress analysis was performed to study the orthotropic nature of composite materials and the effect of the choice of materials on the stress distribution. On the basis of the analysis, a flywheel was designed and tested. Although the wheel delaminated at a speed considerably below the predicted failure speed, the inner ring was analyzed, and it was found that the analytical technique correctly predicted the the stress distribution in the wheel. Premature failure occurred because the radial properties of the composite material could not be determined sufficiently accurately prior to building the wheel, and the radial modulus of elasticity was significantly higher than predicted. As a result of the test, working values for the radial properties of the composite material were determined, the analytical techniques were verified, and the possibility of a delamination type of failure instead of a conventional burst-type failure was demonstrated. (Author)

A68-22542 *
ELECTROCHEMICAL CATALYSIS.
J. O'M. Bockris and H. Wroblowa (Pennsylvania, University, Electrochemistry Laboratory, Philadelphia, Pa.).
IN: COMBUSTION AND PROPULSION; AGARD COLLOQUIUM ON ENERGY SOURCES AND ENERGY CONVERSION, 6TH, CANNES, FRANCE, MARCH 16-20, 1964, PAPERS.
Research sponsored by the Combustion and Propulsion Panel of NATO-AGARD.
Edited by H. M. DeGroff, R. F. Hoglund, J. Fabri, T. F. Nagey, and R. E. Rumbaugh, Jr.
New York, Gordon and Breach, Science Publishers, Inc. (AGARDograph 81), 1967, p. 717-763; Discussion, M. Boudart (California, University, Berkeley, Calif.), J. M. Jenkins (Martech Consultants, Ltd.), and Norman Hackerman (Texas, University, Dept. of Chemistry, Austin, Tex.), p. 763-767. 102 refs.
Research supported by the United Aircraft Co., NASA, and USAF.

Discussion of the factors affecting the rates of chemical and electrochemical reactions. The differences between chemical and electrochemical catalysis arising from the existence of the applied field and from the presence of solvent are shown from the theoretical and experimental points of view. A review of the possible ways to enhance electrocatalysis is presented. The mechanisms of several electrode reactions (oxidation of hydrogen, hydrocarbons, oxalic acid, oxygen reduction) pertinent to fuel cell reactions are discussed in detail, as a prerequisite to all catalytic considerations. An attempt is made to formulate some theory of the mechanism of catalysis, on the basis of an experimental comparison of the reaction rates on various catalysts of hydrogen and oxygen evolution and of ethylene oxidation. Needed trends in research are indicated. (Author)

A68-23903 #
EXPERIMENTAL RESULTS OF A ONE MEGAJOULE INDUCTIVE ENERGY STORAGE SYSTEM.
E. Simon and G. Bronner (Princeton University, Plasma Physics Laboratory, Princeton, N.J.).
IN: SYMPOSIUM ON ENGINEERING ASPECTS OF MAGNETOHYDRODYNAMICS, 9TH, UNIVERSITY OF TENNESSEE, TULLAHOMA, TENN., APRIL 3-5, 1968, PAPERS.
Symposium sponsored by the Space Institute of the University of Tennessee, the American Institute of Aeronautics and Astronautics, the American Society of Mechanical Engineers, and the Institute of Electrical and Electronics Engineers.
Tullahoma, Tenn., University of Tennessee, Space Institute, 1968, p. 15, 16.

Results of tests of a newly conceived one-megajoule inductive energy storage system. The major components of this system are described. The energy storage inductor for this system is a water-cooled air-core coil with optimum shape. The tests demonstrate the feasibility of operating a system of this type. P.v.T.

A68-25659
A RADIOISOTOPE HEATER FOR A SILVER-ZINC BATTERY.
I. Marshall Levy (Hittman Associates, Inc., Baltimore, Md.) and Thomas S. Bustard (Hittman Associates, Inc., Isotopic Power and Radiation Applications Dept., Baltimore, Md.).
IN: NUCLEONICS IN AEROSPACE; PROCEEDINGS OF THE SECOND INTERNATIONAL SYMPOSIUM, COLUMBUS, OHIO, JULY 12-14, 1967.
Symposium sponsored by the U.S. Air Force, the U.S. Atomic Energy Commission, and the Instrument Society of America.
Edited by Paul Polishuk.
New York, Plenum Press, Division of Plenum Publishing Corp., 1968, p. 200-207. 9 refs.
Army-sponsored research.

The use of a radioisotope heater is shown to be feasible as a heat source for maintaining silver-zinc battery temperatures in a low ambient environment. The advantage of this concept is a significant reduction in battery size and weight. The paper, after selection of an isotope and heat source (fuel capsule) design analysis, establishes a conceptual design of a compact silver-zinc battery heated by a radioisotope. (Author)

A68-42515
SEPARATOR MATERIALS FOR LONG LIFE, HIGH RATE THERMAL CELLS.
F. C. Arrance and M. J. Plizga (McDonnell Douglas Corp., Douglas Aircraft Co., Missile and Space Systems Div., Astropower Laboratory, Newport Beach, Calif.).
IN: IECEC '68; INTERSOCIETY ENERGY CONVERSION ENGINEERING CONFERENCE, UNIVERSITY OF COLORADO, BOULDER, COLO., AUGUST 13-17, 1968, RECORD. VOLUME 1.

New York, Institute of Electrical and Electronics Engineers, Inc. (IEEE Publication 68 C 21-Energy), 1968, p. 65-68.

The problems involved in the development of long-life, high energy density thermal cells are discussed with particular emphasis on lithium anode cells with a variety of cathodes in fused LiCl-KCl eutectic electrolyte. The compatibility of a variety of inorganic separators and their characteristics in thermal cell test fixtures are discussed. The test cell data reported indicate the feasibility of this approach for high-rate thermal cell development. (Author)

A68-43812
OPTIMIZATION OF ENERGY STORAGE FOR SOLAR SPACE POWER.
G. C. Szego and B. Paiewonsky (Institute for Defense Analyses, Arlington, Va.).
Energy Conversion, vol. 8, Sept. 1968, p. 71-80.

Study of the conditions under which the solar energy may be stored for powering satellite and space-vehicle systems. The two principal means of such energy storage are: (1) the thermal energy collected from the sun is stored in a suitable heat sink, whence it can be drawn by the power converter during the dark period; and (2) the storage of electrical energy, after conversion during the illuminated period, in batteries for use as electrical energy without conversion during a later period. The optimum mode of energy storage to employ is analyzed for various power histogram profiles

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and for various periods of darkness in orbit. The parameters considered are: (1) efficiencies of the converter, of thermal storage, and of electrical storage; (2) orbital period; (3) fraction of orbital darkness; (4) specific masses of electrical storage, thermal storage, and converter; and (5) the power-time demand of the load. A broad spectral variation of numerical values is employed. The parametric relations are shown graphically and indicate the design conditions under which the optimal design (for minimum mass) requires thermal energy storage, electrical energy storage, or the combination of the two. Z.W.

A69-15330
SECONDARY CELLS WITH LITHIUM ANODES AND IMMOBILIZED FUSED-SALT ELECTROLYTES.
Hiroshi Shimotake, George L. Rogers, and Elton J. Cairns (Argonne National Laboratory, Argonne, Ill.).
(American Chemical Society, Spring National Meeting, 155th, San Francisco, Calif., Mar. 31-Apr. 5, 1968.)
I & EC - Industrial and Engineering Chemistry, Process Design and Development, vol. 8, Jan. 1969, p. 51-56. 17 refs.
AEC-sponsored research.

Secondary cells with a liquid-lithium anode, a fused LiF-LiCl-LiI eutectic electrolyte immobilized as a rigid paste, and a liquid bismuth or tellurium cathode have been investigated in both the discharge and charge modes of operation. The lithium/bismuth cell operating from 380 to 485°C yielded current densities up to 2.2 A/cm^2, and a maximum power density of 0.57 W/cm^2 at 0.6 V. The cell contained an amount of lithium equivalent to 0.25 A-hr; the fully discharged cathode alloy composition was 41 at. % Li in Bi. The lithium/tellurium cell operating at 475°C yielded a short-circuit density of 2.2 A/cm^2, and a maximum power density of 1 W/cm^2 at 0.9 V. This cell contained an amount of lithium equivalent to 6.36 A-hr; the fully discharged cathode alloy composition was 71.6 at. % Li in Te. These performances suggest many applications, including special vehicle propulsion and energy storage. (Author)

A69-23990
U.S. ARMY ELECTRONICS COMMAND, ANNUAL POWER SOURCES CONFERENCE, 22ND, ATLANTIC CITY, N.J., MAY 14-16, 1968, PROCEEDINGS.
Red Bank, N.J., Power Sources Conference Publications Committee, 1968. 141 p.
$15.

CONTENTS:

NICKEL-CADMIUM CELLS FOR OPTIMUM OVERCHARGE CAPABILITY. R. L. Hadley (General Electric Co., Gainesville, Fla.) and A. J. Catotti (General Electric Co., New York, N.Y.), p. 42-46. 8 refs.

CELL DESIGN OPTIMIZATION. L. Belove and A. B. Mundel (Sonotone Corp., Elmsford, N.Y.), p. 46-50. 5 refs.

AUXILIARY ELECTRODE CHARGE CONTROL. F. E. Ford (NASA, Goddard Space Flight Center, Greenbelt, Md.), p. 53-57. 5 refs.

HIGH RATE BATTERY CHARGER SYSTEM. E. Kantner and H. J. Lennon (Gulton Industries, Inc., Metuchen, N.J.), p. 61-65.

STABLE ZINC ELECTRODES. J. Goodkin (Yardney Electric Corp., New York, N.Y.), p. 79-82. 7 refs.

PERFORMANCE WITH STABLE SEPARATORS. A. Himy (McDonnell Douglas Corp., St. Louis, Mo.), p. 82-85.

METAL FLUORIDE COMPOUNDS AS CATHODES FOR THERMAL BATTERIES. C. B. Root and R. A. Sutula (U.S. Navy, Naval Ordnance Laboratory, Silver Spring, Md.), p. 100-102. 6 refs.

SOLID STATE BATTERIES. G. R. Argue, B. Owens, and I. J. Groce (North American Rockwell Corp., Canoga Park, Calif.), p. 103-105. 17 refs.

SOLID ELECTROLYTE BATTERIES. M. N. Hull, p. 106-109. 24 refs.

ATTENDANCE LISTS, p. 129-136.

A70-42454 **Batteries and energy systems.** C. L. Mantell. New York, McGraw-Hill Book Co., Inc., 1970. 231 p. 67 refs. $14.

The construction, principles of operation, intended applications, and technical specifications are given for all currently used commercial types of batteries and energy systems. Preliminary sections detail the fundamental theoretical concepts of batteries as sources of electrical energy. The remainder of the text is divided into sections dealing with individual types of cells in terms of their manufacture, sizes, applications, charging and discharging characteristics, voltages, amperages, and power capabilities. Treated in turn are dry cells (zinc-ammonium chloride-manganese dioxide-carbon system), alkaline cells (zinc-alkali-manganese dioxide system), air depolarized cells, fuel cells, mercury cells, silver batteries, water activated systems, reversible systems, lead secondary cells, alkaline secondary cells, and the nickel-cadmium system. Regenerative electrochemical systems are described together with solar cells and related systems. A section dealing with research into new and special applications contains data for thermal cells and radioisotope power sources. T.M.

A70-46352 **Gas-tight lead storage battery, requiring no attention (Wartungsfreie, gasdichte Bleibatterie).** Harald Reber (Robert Bosch GmbH, Gerlingen, West Germany). *Bosch Technische Berichte*, vol. 3, Aug. 1970, p. 85-88. In German.

A series of experiments has led to the development of a gas-tight battery whose negative plates absorb oxygen. For this function, the important features are the use of pure lead in the plates and exact control of the content of sulphuric acid and paste in the plates. Control electrodes for rapid charging could be developed through the use of catalysts. (Author)

A71-13041 **Lithium-nickel sulfide batteries.** Raymond Jasinski, Lewis Gaines, Gary Hansen, and Susan Carroll (Tyco Laboratories, Inc., Waltham, Mass.). In: Power Sources Symposium, 24th, Atlantic City, N.J., May 19-21, 1970, Proceedings. (A71-13026 03-03) Symposium sponsored by the U.S. Army. Red Bank, N.J., PSC Publications Committee, 1970, p. 98-100. Contract No. N00019-68-60402.

Consideration of the lithium-nickel sulfide system as a high energy density, long shelf life battery. Prototype cells have yielded in excess of 100 watt-hr/lb when discharged at low rates, both at room and elevated temperatures. Laboratory cells using improved electrolyte solutions should give useful discharges down to -40 C. These results are directly applicable to the prototype cells described. A long shelf life system is implied by long-term tests on the compatibility of the battery components and from the low solubility of the Ni3S2 electrode in the cell electrolyte. F.R.L.

A71-14767 **American Society of Mechanical Engineers, Petroleum Mechanical Engineering and Pressure Vessels and Piping Conference, Denver, Colo., September 13-17, 1970, Proceedings.** *ASME, Transactions, Series B - Journal of Engineering for Industry*, vol. 92, Nov. 1970. 131 p.

Contents:

The effect of biaxial stresses on fatigue and fracture. J. J. Kibler (GE Solid Mechanics Laboratory, Philadelphia, Pa.) and R. Roberts (Lehigh University, Bethlehem, Pa.), p. 727-734. 19 refs.

Analysis and design of ellipsoidal pressure vessels heads. E. P. Esztergar and H. Kraus (Rensselaer Polytechnic Institute, East Windsor Hill, Conn.), p. 805-817. 29 refs.

Analysis of shells of revolution formed of closed box section. Z. Zudans (Franlin Institute, Philadelphia, Pa.) and F. H. Gregory (U.S. Army, Ballistics Research Laboratories, Aberdeen Proving Ground, Md.), p. 818-826. 18 refs.

Analysis of stresses in shallow spherical shells with periodically spaced holes. L. E. Hulbert and F. A. Simonen (Battelle Columbus Laboratories, Columbus, Ohio), p. 834-840. 12 refs.

A72-33894 **Problems of high temperature ZrO2 - Solid electrolyte fuel cells.** H. Tannenberger (Battelle, Geneva, Switzerland). In: From electrocatalysis to fuel cells; Proceedings of the Seminar, Seattle, Wash., December 9-11, 1970. Seattle, University of Washington Press, 1972, p. 235-246. 23 refs.

The use of cubic stabilized zirconia as a solid electrolyte in a fuel cell is discussed in relation to a high-temperature fuel cell system which would be an efficient and economical energy-conversion device. The optimalization of the entire system makes it possible to specify the performance requirements for single elements and battery modules of the fuel cell itself. Some problems that are pertinent to the development of such a system are: finding the techniques to produce electrolyte layers between 10 and 50 microns thick in stable form and selecting proper materials for the electrodes. The choice of the anode metal is difficult, since those metals that are selected for their stability adhere to the electrolyte. The choice of cathode material is even more difficult because of the necessary chemical stability under oxidizing conditions. The noble metals are shown to be unsatisfactory for the purpose, and the stable oxides, which may also be considered, are generally unsuitable because of their low electronic conductivity and failure to meet other requirements. At present, only indium oxide is considered as a satisfactory cathode material. D.F.L.

A73-14744 **Material requirements for the superflywheel.** D. W. Rabenhorst (Johns Hopkins University, Silver Spring, Md.). In: Opportunities in materials; Proceedings of the Fourth Buhl International Conference, Pittsburgh, Pa., November 16-18, 1971. Pittsburgh, Carnegie Press, 1971, p. 195-205. 7 refs.

The superflywheel configurations utilize essentially straight filaments or thin rods. The new superflywheels have demonstrated a capability of storing about 30 watt-hours per pound. It appears certain that with growing operational experience the energy storage capacity will be significantly improved. Potential applications of the new device are related to vehicles, tools, power supplies, aircraft, spacecraft, and watercraft. A general description of the superflywheel system is given. Materials cost is discussed together with environmental aspects, materials stress and weight. G.R.

A73-25979 # **New concepts in mechanical energy storage.** D. W. Rabenhorst (Johns Hopkins University, Silver Spring, Md.). In: Energy 70; Proceedings of the Fifth Intersociety Energy Conversion Engineering Conference, Las Vegas, Nev., September 21-25, 1970. Volume 1. Hinsdale, Ill., American Nuclear Society, 1972, p. 2-95 to 2-99. 12 refs.

A unique flywheel configuration is described which provides a new level of applicability for present and future anisotropic materials, including whisker materials. An energy storage capability of 30 watt-hours per pound of flywheel weight should be readily available, while performance in excess of this value is predicted for the future. Some additional improvements described include (1) a magnetic fluid hermetic seal that makes it possible to locate bearings and other equipment outside the vacuum can for lower drag and better lubrication, and (2) a new magnetic fluid bearing. T.M.

A73-38415 # **Modern control techniques applied to energy conservation flight control systems.** A. J. Verderese (Avco Everett Research Laboratory, Everett, Mass.). In: Intersociety Energy Conversion Engineering Conference, 8th, Philadelphia, Pa., August 13-16, 1973, Proceedings. New York, American Institute of Aeronautics and Astronautics, Inc., 1973, p. 609-613.

Analysis of an energy conservation flight control system consisting of a motor directly geared to a flywheel driving a power hinge through a mechanical servo. The primary goals of this investigation are to: (1) determine the 'appropriate' motor/flywheel combination based on extreme synthesized duty cycles, while constraining the motor speed to never go below 3/4 rated speed; and (2) for the same duty cycles and motor constraint, optimize the motor/flywheel combination. The results indicate the pronounced advantage, in terms of reduced size and weight, when optimizing the above system as against just using a conservative design approach. (Author)

N68-14818* National Aeronautics and Space Administration, Washington, D. C.
ELECTROCHEMICAL SPACE POWER SOURCES
Ernst M. Cohn 1967 122 p refs Presented at the AGARD/NATO Lecture Series, Brussels, Belgium, 2-5 October 1967
(NASA-TM-X-60795) CFSTI: $3.00 CSCL 10B

After a general discussion of electrochemical energy storage and electricity generation in aerospace, the thermodynamic and kinetic electrochemical basis for these devices, as well as criteria for selecting electrochemically active materials and estimating energy densities are presented. The following three sections cover primary and secondary equipment, either now being used or of potential usefulness in space. The last two sections relate some design criteria for space power systems and consider possible earth-bound applications of space-oriented electrochemical research and development. Author

N68-15938 Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaire.
ENERGY STORAGE POSSIBILITIES OF SUPERCONDUCTORS WITH A VIEW TO LARGE POWER DISCHARGES [STOCKAGE D'ENERGIE POSSIBILITIES DES SUPRA-CONDUCTEURS EN VUE DES DECHARGES DE GRANDES PUISSANCES]
Jean Sole Jun. 1967 14 p refs In FRENCH
(CEA-R-3243)

Condensers, turning machines, combustible piles, accumulators, and explosives are considered in relation to energy storage possibilities of superconductors. Energy supply, role of dielectrics, and energy density in dielectric materials are discussed for the semiconductors; and attention is given to the optimization of energy storage and release of energy. Transl. by M.W.R.

N68-17798 Pennsylvania Univ., Philadelphia.
PROSPECTS FOR THERMAL ENERGY STORAGE
Manfred Altman *In* AGARD Combust. and Propulsion 1967 p 135-149 refs
(Grant NsG-316)

This paper is concerned with the problem of developing a method of storing thermal energy by the utilization of the heat of fusion of suitable compounds. The first part of the paper discusses the incentives for the development of this type of energy storage. The second part deals with the problem of synthesising suitable materials. The third part discusses the problem of obtaining the needed heat transfer properties. The main conclusions of this work are as follows: (1) A good case can be made for space power systems utilizing thermal energy storage. (2) This is predicated on technical developments which appear probable, but which have not yet been accomplished. (3) A great deal of work remains to be done in two major research areas. One, the determination of phase diagrams of promising eutectic mixtures, and two, the experimental and theoretical determination of heat transfer properties. (4) A carefully planned systematic approach is needed to obtain the information necessary for systems comparisons. Author

N68-23614# Defense Dept., Washington, D. C.
INTERIOR COATING SYSTEMS FOR SURFACES IN CONTACT WITH PETROLEUM FUELS Technical Manual

Mar. 1968 57 p refs
(AD-666969)

This manual is intended to be a technical reference and guide to the materials, application methods, inspection techniques and specifications that will yield the best internal coatings for surfaces of containers in contact with petroleum fuels. Its purpose is to serve as a tool that will help toward improved and uniform practices in the selection and application of the most appropriate coatings. Comments are included on coating surfaces of containers--from the 5-gallon can to the largest storage tank or tank vessel, both metal and nonmetal, whether used for storage or for handling military fuels. TAB

N68-33238*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
A SNAP-8 BREADBOARD SYSTEM. OPERATING EXPERIENCE.
J. N. Hodgson (Aerojet-General Corp., Azusa, Calif.) and R. P. Macosko Aug. 1968 35 p refs Presented at the IEEE Intersoc. Energy Conversion Eng. Conf., Boulder, Colo., 13-16 Aug. 1968
(NASA-TM-X-61161; Rept.-3511) CFSTI: HC $3.00/MF $0.65 CSCL 18N

SNAP-8 is a 35 kw nuclear-electric space power system. The system operates on a mercury Rankine cycle using NaK (eutectic sodium-potassium mixture) as the heat-input and heat-rejection working fluids. The test program has evolved from an initial component test phase to testing of complete breadboard systems. Extensive testing has provided information on the relationships between components and the system. Data are presented showing the perturbations, and their consequences, inherent in a dynamic system. Cause and effect relative to boiling instability, system contamination, inventory control, testing mishaps, and transient operation are presented as observed during the test program. The breadboard approach to system testing and design has proven appropriate. A close simulation to flight-configuration testing has been accomplished while maintaining the design flexibility of a breadboard system. Author

N69-11907# Institute for Defense Analyses, Arlington, Va. Science and Technology Div.
ONE WATT 30-DAY PLUS POWER SOURCES
Robert C. Hamilton Aug. 1968 50 p refs
(Contract DAHC15-67-C-0011)
(AD-675936; IDA/HQ-68-8703; RP-P-412) Avail: CFSTI CSCL 10/3

Four alternative power sources are considered as replacements for the mercury cells which are currently used. Of these, silver-zinc batteries can double the watt-hour per pound performance and have twice the life of mercury cells; zinc-air batteries could improve the w-hr/lb performance another 50 percent. Hydrogen-air and hydrogen-oxygen fuel cells offer no advantage over present power sources. Solar cell-battery power systems are advisable for some applications. Author (TAB)

N69-12431# TRW Systems Group, Redondo Beach, Calif.
MODULAR ENERGY STORAGE AND CONDITIONING (MESAC) STUDY Interim Report
10 Dec. 1968 75 p
Avail: CFSTI

As a means of overcoming the relative unpredictability of battery power systems reliability, an assessment is made of the modular energy storage and conditioning (MESAC) concept which combines electronics with batteries in a centrally controlled modular system. Basically, the system consists of an internally redundant single central control unit for sensing the system bus voltage and controlling the operation of the electronics in each of several energy storage units (ESU). For the analysis, the ESU was divided into two power handling sections: the uplink (discharge) converter; and the downlink (charge) converter. Circuit implementation tradeoff studies were conducted, and equations are included to describe the performance, efficiency, and weight of the uplink converter. Equations developed to describe the downlink converter performance contain compensation for the less-than-unity ampere-hour efficiency of battery cells on charge. Battery failure rates are defined, and a battery reliability model is developed. The computer source program is included. M.G.J.

N69-13298# Kernforschungsanlage, Juelich (West Germany).
SOME PROBLEMS OF LIGNITE GASIFICATION BY MEANS OF HIGH-TEMPERATURE NUCLEAR REACTOR HEAT [UEBER EINIGE PROBLEME BEI DER VERGASUNG VON BRAUNKOHLEN MIT HOCHTEMPERATUR-KERNREAKTOR WAERME]
K. Kugeler und A. T. Bhattacharyya Aug. 1968 37 p refs In GERMAN
(JUL-554-RG) Avail: CFSTI

A system and a facility for the generation of electric current and gas are described. Data of the speed of gasification of lignite with steam are given in addition to a description of the basic gasification reactions and their dependence on temperature and pressure. The gas composition that can be expected is calculated as a function of the variables. Several possible arrangements of the system are shown. The balances of quantity and energy for the gasification space give a first indication of the amounts of synthesis gas that can be expected and the requirements for heat from the nuclear reactor. A methanol bath for the removal of CO_2 and H_2S from the synthesis gas is briefly described. The efficiency of the entire plant is discussed, and prices for the synthesis gas are estimated. Transl. by K.W.

N69-14302# Los Alamos Scientific Lab., N. Mex.
SOLID SOLUTION OXIDE FUELS FOR SPACE ELECTRIC POWER HEAT SYSTEM
J. A. Leary [1968] 8 p Presented at Potential Contractors Conf on NAVSAT, Albuquerque, N. Mex., 4 Jun. 1968
(Contract W-7405-ENG-36)
(LA-DC-9686; CONF-680626-1) Avail: CFSTI

A brief review of progress in the development of solid solution oxide fuel disks for power systems in space vehicles is presented. Phases discussed include crystallographic structure, preparation from powders, chemical composition, compatibility, power densities, and physical properties. NSA

N69-15054 Oklahoma State Univ., Stillwater.
A SYSTEM FOR THE ECONOMIC ANALYSIS OF BALANCED ENERGY CONVERSION AND STORAGE SYSTEMS
Arthur Bruckner, II (Ph.D. Thesis) 1967 231 p
Avail: Univ. Microfilms: HC $10.60/Microfilm $3.00 Order No. 68-8369

A simulation system is developed to examine the economic feasibility of combined energy conversion and storage systems on the basis of annual energy demand. Annual demand is the basis for the optimization trade-off function in order to realize the full savings potential from generation plant investment as well as short term advantages in fuel economies. The objectives are the determination of storage equipment requirements so that the necessary or high potential research directions are identified in the early stages of a research and development project. Some case study indications are: no major annual effects on fuel costs; equipment cost-advantages between storage procedures; probable cost advantages from over-capacity generation facilities in uncon-

ventional energy source systems. Extended storage technology research in balanced nuclear plant generation and storage systems is a recommendation. Dissert. Abstr.

N69-18042*# TRW Systems, Redondo Beach, Calif.
BATTERIES FOR SPACE POWER SYSTEMS
Paul Bauer Washington NASA 1968 314 p refs
(NASA-SP-172) Avail: CFSTI CSCL 10C

A summary of all NASA sponsored work on batteries and related electrochemistry is given. Basic processes in a galvanic cell and operational and test problems of all types of batteries are outlined and data requirements for the design of sophisticated, high-efficiency space electric-power systems are analyzed. The validity and usefulness of individual battery systems for spacecraft applications are evaluated with emphasis on battery selection and integration into high efficiency electric-power systems. G.G.

N69-24894*# General Electric Co., Gainesville, Fla. Battery Business Section.
OPTIMIZATION OF DESIGN PARAMETERS FOR SPACECRAFT NICKEL-CADMIUM CELLS CONTAINING RECOMBINATION AND CONTROL ELECTRODES Quarterly Report, Aug. – Oct. 1968
P. R. Voyentzie and G. Rampel Mar. 1969 45 p ref
(Contract NAS5-11547)
(NASA-CR-100813; QR-2) Avail: CFSTI CSCL 10B

The cycle capability of cells constructed with oxygen-sensing (signal) and oxygen recombination electrodes was investigated. The cycle regimes in the tests were more rigorous than normally used aboard spacecraft, and ambient temperatures and depths-of-discharge were greater than those normally used, thereby permitting faster evaluation of the effect of differences in the subgroup experiments. The work aims to extend the operational capability of the nickel-cadmium space battery. Cycle data indicate a requirement for negative precharge levels greater than 75% of the excess negative capacity for cells (equivalent to a negative-positive ratio of 1.40 negative precharge) which are to be cycled to depths-of-discharge approaching 75% and/or at ambient temperatures approaching 40°C. The recombination-to-negative load resistance value proved to be critical for optimum cycle life. A 2.0 ohm value for this resistor yields significantly greater cycle life at 40°C than does a value of 0.1 ohm. A decrease in signal electrode sensitivity was noted after 40°C exposure. Author

N69-34688# Bosch (Robert) G.m.b.H., Stuttgart (West Germany).
TECHNICAL REPORTS, VOLUME 2, NUMBER 5 [TECHNISCHE BERICHTE, BAND 2, HEFT 5]
Nov. 1968 57 p refs In GERMAN; ENGLISH summaries
Avail: CFSTI

CONTENTS:

N69-34689# Bosch (Robert) G.m.b.H., Stuttgart (West Germany). Laboratorium für Elektrochemie.
DEVELOPMENT OF BATTERIES FOR AUTOMOBILES WITH ELECTRIC PROPULSION [ENTWICKLUNG VON BATTERIEN FUER ELEKTRISCH ANGETRIEBENE KRAFTFAHRZEUGE]
Hermann Dietz *In its* Tech. Rept., Vol. 2, No. 5 Nov. 1968 p 211–219 refs In GERMAN; ENGLISH summary

Avail: CFSTI

Power sources for electric automobiles require a high energy/weight ratio and favorable service and maintenance at low initial and operating costs. This is a survey on existing batteries and systems under development. Fuel cells, metal-air, non-aqueous, high temperature, and organic electrolyte batteries are discussed. ESRO

N70-22537# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
PRIMARY ENERGY STORAGE AND THE SUPER FLYWHEEL
D. W. Rabenhorst Sep. 1969 66 p refs
(Contract NOw-62-0604-C)
(AD-697906; APL-TG-1081) Avail: CFSTI CSCL 10/3

This report describes new flywheel configurations that promise an order of magnitude improvement as energy storage devices. As presently conceived, the energy density has been improved over ten times, with the prospect for additional improvement in performance as the next generation of high strength uniaxial filamentary materials becomes available. This super flywheel is significant in its application to the urban electric vehicle. Instead of only being used to reduce the acceleration power requirements, as has been proposed in many studies, the new flywheel can actually be used as the primary energy source, and batteries can be eliminated altogether. Many other applications are also discussed. Author (TAB)

N70-38713* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
SWITCHING MECHANISM WITH ENERGY STORAGE MEANS Patent
William A. Leavy, inventor (to NASA) Issued 21 Jul. 1964 (Filed 18 Sep. 1961) 5 p Cl. 200-39
(NASA-Case-XGS-00473; US-Patent-3,141,932; US-Patent-Appl-SN-139012) Avail: US Patent Office CSCL 13I

A driven switch actuation mechanism, with a mechanical reset feature capable of completing its operation cycle after the input drive is deactivated, is described. A rotatable coil spring stores energy as a result of the rotation of the driven device, such as a tape recorder, and is triggered by the device when it reaches a desired position. The stored energy is sufficient to allow the cutoff switch to be actuated and to return the switch to its normal operating position. N.E.N.

N71-11913# McElroy (Ralph) Co., Austin, Tex. Custom Div.
ENERGY STORAGE IN A SUPERCONDUCTING WINDING [STOCKAGE D'ENERGIE DANS UN ENROULEMENT SUPRACONDUCTEUR]
M. Ferrier [1969] 11 p refs Transl. into ENGLISH from Bull. Inst. Int. Froid, Annexe (France), no. 1, 1969 p 425–432

Sponsored in part by AEC Prepared for Los Alamos Scientific Lab.
(LA-tr-70-9) Avail: NTIS

The problems of energy storage on the scale of the fluctuations of the national or regional load, i.e., of the order of 1,000 MWh are examined. Various configurations are reviewed, and the short solenoid of circular cross section is selected as being economically the most favorable. The field produced and the distribution of the mechanical constraints are discussed for this configuration. An examination of the various losses (at the surface of the cryostat, by mechanical or magnetic hysteresis) shows that they are acceptable. The circulation of the cryogenic fluid is discussed in detail, and it is shown that the ratio of stabilizing material to superconducting material can be reduced to 10:1. Finally, the modes of connecting the storage device to the grid are examined and there is a discussion of the optimum size of the installation as a function of the financial benefits that can be attributed to the different services provided by the device. Author (NSA)

N71-13514*# Cambridge Thermionic Corp., Mass.
MODIFICATION OF DC MOTOR WITH MAGNETICALLY SUSPENDED ROTOR TO GIVE HIGHER MOMENTUM STORAGE CAPACITY, SUPPLEMENT Technical Report, 1 Apr. – 31 Jul. 1970
31 Jul. 1970 21 p
(Contract NAS5-11585)
(NASA-CR-115792) Avail: NTIS CSCL 09E

A 2.1 lb. flywheel was added to the existing rotor which necessitated improving the total magnetic support capability of the bearing by adding two more ridges to each rotor and stator pole face. The ridges increased the support capability of the bearing without increasing the power requirement. A stronger permanent magnet was installed in the rate generator circuit so that a sufficient rate signal could be generated with the increased rotor weight. The existing motor and bearing housing was discarded in favor of a rigid clamping frame to accommodate the six inch diameter flywheel. A portion of the old housing was used to support the motor armature and commutator. These modifications improved the support capability, stiffness, and efficiency with no increase in power consumption. Author

N71-17471*# TRW Systems Group, Redondo Beach, Calif.
MODULAR ENERGY STORAGE AND CONDITIONING (MESAC) STUDY Final Report
Jul. 1970 130 p
(Contract NAS5-9178)
(NASA-CR-116510) Avail: NTIS CSCL 10A

The concept of a centrally controlled modular energy storage and conditioning system for improved reliability of power systems containing batteries was studied. Estimated weight, efficiency, and reliability were analyzed and compared with conventional systems and a breadboard phase containing typical parallel energy storage units. Results established that high efficiency direct energy transfer from source to load without loss elements and at regulated voltages is feasible. A modification of the drive circuitry is necessary to increase boost ratios. The breadboard performed all required functions and continued to operate at rated power levels after simulated failure of one of the energy storage units. G.G.

N71-22199# National Research Council of Canada, Ottawa (Ontario). Low Temperature Lab.
PRESENT STATUS OF ELECTRIC AUTOMOBILES
J. J. Gottlieb *In its* Quart. Bull. of the Div. of Mech. Eng. and the Natl. Aeron. Estab., Oct.–Dec. 1970 31 Dec. 1970 p 1–38 refs (See N71-22198 11-15)
Avail: NTIS

The scope of the study includes developments in batteries, fuel cells and hybrid systems, controllers, chargers, electric motors, and body design features. Problems due to thermal conditioning and corrosion are also discussed. Author

N71-23515*# Translation Consultants, Ltd., Arlington, Va.
ENERGY STORAGE CAPABILITIES OF SUPERCONDUCTORS IN VIEW OF HIGH POWER DISCHARGE [STOCKAGE D'ENERGIE POSSIBILITIES DES SUPRACONDUCTEURS EN VUE DES DECHARGES DE GRAND PUISSANCES]
J. Sole Washington NASA Apr. 1971 25 p refs Transl. into ENGLISH of CEA, Saclay, France report CEA-R-3243
(Contract NASw-2038)
(NASA-TT-F-13585; CEA-R-3243) Avail: NTIS CSCL 10C

The energy storage capabilities of superconductors and the associated energy release at high power is discussed. A parallel and comparison is drawn between existing energy storage mechanisms (condensers, rotating machines, reactors, batteries, explosives) and the so called superconductors as seen from French experimental results. Direct comparisons are drawn by using material evaluations, performance equations and cost price ratios. Author

N72-11410# Lockheed Missiles and Space Co., Sunnyvale, Calif. Ground Vehicle Systems.
FLYWHEEL FEASIBILITY STUDY AND DEMONSTRATION Final Report
R. R. Gilbert, J. R. Harvey, G. E. Hever, and L. J. Lawson
30 Apr. 1971 165 p refs
(Contract EHS-70-104)
(PB-200143; LMSC-D0079115) Avail: NTIS CSCL 13I

The feasibility of application of flywheel only and flywheel hybrid propulsion systems to four classes of vehicles is studied. Author (GRA)

N72-11982*# TRW Systems Group, Redondo Beach, Calif.
THE 20 kW BATTERY STUDY PROGRAM Final Report
30 Jul. 1971 421 p refs
(Contract NAS5-21066)
(NASA-CR-122296; TRW-13837-6001-R0-00) Avail: NTIS HC $6.00/MF $0.95 CSCL 10C

Six battery configurations were selected for detailed study and these are described. A computer program was modified for use in estimation of the weights, costs, and reliabilities of each of the configurations, as a function of several important independent variables, such as system voltage, battery voltage ratio (battery voltage/bus voltage), and the number of parallel units into which each of the components of the power subsystem was divided. The computer program was used to develop the relationship between the independent variables alone and in combination, and the dependent variables: weight, cost, and availability. Parametric data, including power loss curves, are given. Author

N72-12020*# Astro Research Corp., Santa Barbara, Calif.
APPLICATION OF ISOTENSOID FLYWHEELS TO SPACECRAFT ENERGY AND ANGULAR MOMENTUM STORAGE Final Report
L. R. Adams Washington NASA Feb. 1972 66 p refs
(Contract NAS7-728)
(NASA-CR-1971; ARC-R-423) Avail: NTIS CSCL 09E

Studies and experiments with the concept for expendable flywheel structures, using isotensoid filament geometry and centrifugal force, are reported. Systems employing the isotensoid flywheel are evaluated in terms of energy density (watt-hr/lb) and angular momentum density (ft-lb-sec/lb) and compared with standard electrochemical storage devices and rigid control-moment gyro wheels. Author

N72-17829# Los Alamos Scientific Lab., N.Mex.
ENERGY STORAGE AND SWITCHING WITH SUPERCONDUCTORS
H. L. Laquer and F. L. Ribe 1971 3 p Presented at the Intern. Working Session on Fusion Reactor Technol. Conf., Oak Ridge, Tenn., 1 Jul. 1971
(LA-DC-12990) Avail: NTIS

Inductive magnetic energy storage with superconductors or cryogenic aluminum conductors is discussed in regard to its use in providing the magnetic fields needed in pulsed thermonuclear reactors and in some large-scale pulsed plasma physics experiments designed to demonstrate the scientific feasiblity of controlled fusion. NSA

N72-26656# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Stuttgart (West Germany). Inst. fuer Energiewandlung und Elektrische Antriebe.
ENERGY STORAGE IN SUPERCONDUCTING COILS
C. Carpetis 6 Mar. 1972 59 p refs In GERMAN; ENGLISH summary
(DLR-FB-72-10) Avail: NTIS HC $5.00; DFVLR Porz-Wahn; 20, DM

The storage of energy in superconducting coils and the capital costs of such a practice are discussed. The field intensity in the coil, the current density of the superconductor, and a characteristic dimension of the coil are related to the geometry of coil and the energy stored in it. Such data allows optimization of the coil with respect to its specific mass. A comparison of the superconducting coil with other energy storage systems revealed that the superconducting systems are characterized by relatively low specific mass and low capital costs, especially where high discharge power is required. Author

N73-13997# Phillips Scientific Corp., Bartlesville, Okla.
INVESTIGATION OF NAVY AIRCRAFT FUEL DISPENSING METHODS
D. P. Keeler and E. E. Kleinmann Apr. 1972 212 p
(Contract N00025-71-C-0026)
(AD-748211) Avail: NTIS CSCL 15/5

The report is the result of study to determine the most effective, practical, and economical system for onshore fueling of Navy aircraft, including fighters, patrol, helicopters, and transport aircraft. The Recommended Service Station Fueling System is a pressure system automatically controlled by fuel demand, utilizing groups of pumps, filter-separators, and a pipeline distribution system arranged for extreme flexibility and simplicity in operation. A minimum of hydraulic and electric controls are used, and no radio or telephone is required for coordination of fueling. The Recommended Service Station Fueling System consists of fueling spots to which aircraft come for fueling. Each fueling spot consists of a meter, a primary and secondary pressure control valve, a filter-separator, and a loading hose or arm to transfer fuel from a pipeline to the aircraft. Author (GRA)

N73-19061# Argonne National Lab., Ill.
DEVELOPMENT OF HIGH-SPECIFIC-ENERGY BATTERIES FOR ELECTRIC VEHICLES Progress Report, Feb. - Jul. 1972
E. J. Cairns, E. C. Gay, R. K. Steunenberg, H. Shimotake, J. R. Selman, T. L. Wilson, and D. S. Webster Sep. 1972 114 p refs
(Contract W-31-109-eng-38)
(ANL-7953) Avail: NTIS

The technology required to construct secondary batteries having the performance capabilities required for pollution free electric automobiles is discussed. Batteries for this application should have an energy storage capability of 220 W/kg. Their cost should not exceed about $10/KW-hr of energy storage capability. Lithium/sulfur cells using a molten lithium halide-containing electrolyte and operating at 360 to 390 C have achieved capacity densities of up to 0.9 A-hr/sq cm (above 1 V) at a current density of 0.9 A/sq cm with a cycle life of more than 2000 cycles during 7000 hr of operation. The enclosed mixed-cathode Cell L-9 had a cycle life and lifetime of 150 cycles and 1000 hr, respectively, with a capacity density up to 0.4 A-hr/sq cm at a current density of 0.24 A/sq cm to a 1.0-V cutoff. These results are consistent with the specific energy and specific power goals, but the cycle life and the sulfur electrode performance require further improvement. Author

N73-21084# Sandia Labs., Albuquerque, N.Mex.
ADVANCEMENTS IN PELLET-TYPE THERMAL BATTERY TECHNOLOGY
D. M. Bush Oct. 1972 66 p refs Sponsored by AEC
(SC-RR-69-497-A) Avail: NTIS

The development of a prototype thermal battery incorporating a pelletized heat source is reported. Recent batteries, operating at a 61 percent higher current density, gave an average life of 13.8 minutes. The Ca/LiClKCl, $CaCrO_4$/Fe system has been used throughout. Changes made to the battery design that have resulted in improved performance included a modified heat source, the use of bimetal anodes, a more efficient electrolyte immobilizer, special heat buffer pellets, new powder processing techniques, a light-weight container, and a new insulating material. Techniques have been devised to record cell stack temperatures during battery discharge. The investigations leading to these design changes are discussed and test results that have been obtained with recent control batteries are presented. Author

N73-23014# Magnetic Corp. of America, Waltham, Mass.
DEVELOPMENT OF PULSED HIGH ENERGY INDUCTIVE ENERGY STORAGE SYSTEMS, VOLUME 1 Technical Report, Apr. 1971 - Apr. 1972
Edward J. Lucas, William F. B. Punchard, and Richard J. Thome Dec. 1972 231 p
(Contract F33615-71-C-1454; AF Proj. 3145)
(AD-755359; AFAPL-TR-72-38-Vol-1) Avail: NTIS CSCL 10/2

Major problems associated with the design of a repetitively pulsed 100 kJ energy storage system are explored and solutions presented. Recommendations as to the design of future systems are made. Based on the results of a theoretical analysis into loss mechanisms in copper/superconductor composites, a braid composed of 4.5 x 10 to minus 3rd power inch diameter strands was selected for further investigation. Coils having stored energies of about 1 and 10 kJ were constructed from this braid and loss measurements made while the coils were being repetitively pulsed at rates of 1 and 5 pulses per second. Author (GRA)

N73-26054# Magnetic Corp. of America, Waltham, Mass.
DEVELOPMENT OF PULSED HIGH ENERGY INDUCTIVE ENERGY STORAGE SYSTEMS. VOLUME 3: WEIGHT OPTIMIZATION FOR ENERGY STORAGE, COIL, CRYOGEN AND DEWAR Technical Report, Apr. 1971 - Apr. 1972
Edward J. Lucas, William F. B. Punchard, and Richard J. Thome Wright-Patterson AFB, Ohio AFAPL Dec. 1972 109 p
(Contract F33615-71-C-1454; AF Proj. 3145)
(AD-755360; AFAPL-TR-72-38-Vol-3) Avail: NTIS CSCL 10/2

The report provides weight estimates for possible configurations which may be used in one of these subsystems, that which is devoted to energy storage. For the purposes of this study, it will be assumed that the energy storage subsystem consists of three components: (1) the cryogenic coils, (2) the cryogen and (3) the dewar. The limits of the subsystem are the electrical terminals entering and leaving the dewar. All other components are assumed to be located in other subsystems. The method of determining the weights of the components of the subsystem will be discussed, followed by a discussion of the manner in which subsystems were optimized. The section closes with tables giving characteristics of weight optimized systems for a range of energy, pulse length, total pulses, wire diameter, and copper to superconductor ratio. GRA

N73-30058# Argonne National Lab., Ill.
LITHIUM/SULFUR BATTERIES FOR OFF-PEAK ENERGY STORAGE: A PRELIMINARY COMPARISON OF ENERGY STORAGE AND PEAK POWER GENERATION SYSTEMS
M. L. Kyle, E. J. Cairns, and D. S. Webster Mar. 1973 116 p refs
(Contract W-31-109-eng-38)
(ANL-7958) Avail: NTIS HC $5.45

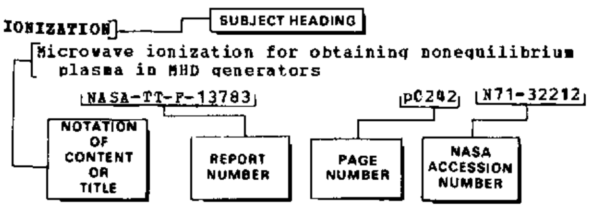
The use of lithium/sulfur batteries as load-leveling devices in electrical utility networks could provide both economic and ecological benefits in meeting the growing demand for energy. A battery designed for this application should have an initial capital cost of $12 to $15/kW-hr of energy storage capacity and a lifetime of at least five years. A typical duty cycle is expected to be a 10 to 14 hr discharge followed by a 4 to 8 hr charge with the battery operating about 5 days per week. Economic and cell performance goals for the development of a battery system are presented. A preliminary comparison of the costs of batteries, pumped hydroelectric storage and gas turbines indicates that, under some conditions, batteries should be considered as load-leveling devices. The lithium/sulfur battery system is in too early a state of development to accurately predict its place in the utility system. Author (NSA)

N73-31676*# Kanner (Leo) Associates, Redwood City, Calif.
SUPERCONDUCTIVE ENERGY STORAGE
S. L. Wipf Washington NASA Sep. 1973 43 p refs Transl. into ENGLISH of "Supraleitende Energiespeicher", Max-Planck-Inst. fuer Plasmaphys., Garching, West Germany, report IPP-2/211, Feb. 1973 39 p
(Contract NASw-2481)
(NASA-TT-F-15109; IPP-2/211) Avail: NTIS HC $4.25 CSCL 20L

Superconductive energy storage is surveyed with regard to advantages, problems and applications. Advantages are large capacity and discharge rate, and relatively high energy density. Problems are optimization of coil form, discharge, development of a suitable superconducting switch, and minimization of alternating-current losses in order to maintain superconduction during discharge. Some proposed solutions are outlined. Envisioned applications include pinch experiments in plasma physics directed toward a pulsed fusion reactor, and power supply for lasers. Author

SUBJECT INDEX

Typical Subject Index Listing



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PERSONAL AUTHOR INDEX

Typical Personal Author Index Listing

BOEHM, J. — PERSONAL AUTHOR

Calculation and comparison of the economics of electrochemical fuel cells

NASA-TT-F-15147 p0254 N73-31991

TITLE — REPORT NUMBER — PAGE NUMBER — NASA ACCESSION NUMBER

Listings in this index are arranged alphabetically by personal author. The title of the document provides the user with a brief description of the subject matter. The report number helps to indicate the type of document listed (e.g., NASA report, translation, NASA contractor report). The page and accession numbers are located beneath and to the right of the title, e.g., p0254 N73-31991. Under any one author's name the accession numbers are arranged in sequence with the *IAA* accession numbers appearing first.

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CORPORATE SOURCE INDEX

ENERGY / *A Special Bibliography*

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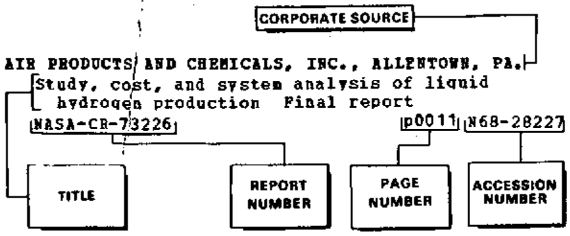

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CONTRACT NUMBER INDEX

Typical Contract Number Index Listing

NASW-1427 p0047 N68-16882

CONTRACT NUMBER — PAGE NUMBER — NASA ACCESSION NUMBER

Listings in this index are arranged alphanumerically by contract number. Under each contract number, the accession numbers denoting documents that have been produced as a result of research done under that contract are arranged in ascending order with the IAA accession numbers appearing first. The accession number denotes the number by which the citation is identified in either the IAA or STAR section. Preceding the accession number is the page number in the abstract section in which the citation may be found.

REPORT/ACCESSION NUMBER INDEX

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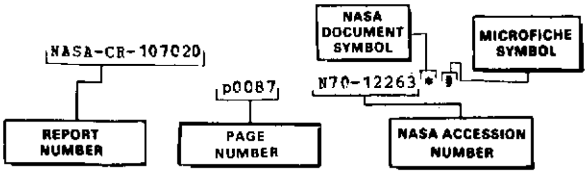

Listings in this index are arranged alphanumerically by report number. The number indicates the abstract page on which the citation is located. The accession number denotes the number by which the citation is identified. An asterisk (*) indicates that the item is a NASA report. A pound sign (#) indicates that the item is available on microfiche. A plus sign (+) indicates a document that cannot be microfiched but for which one-to-one facsimile is available.

ACCESSION NUMBER INDEX

ENERGY / *A Special Bibliography*

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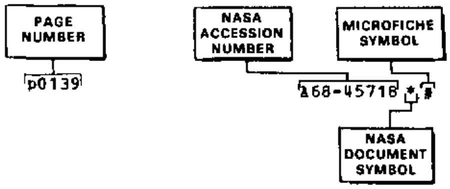

Listings in this index are arranged alphanumerically by accession number. The page number identifies the abstract page on which the citation appears. The IAA or STAR accession number denotes the number by which the citation is identified on that page. An asterisk (*) indicates that the item is a NASA document. A pound sign (#) indicates that the item is available on microfiche. A plus sign (+) indicates a document that cannot be microfiched but for which one-to-one facsimile is available.

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